ISSN 0181-1568

CRYPTOGAMIE

ALGOLOGIE

TOME 12 Fascicule 4 1991

LABORATOIRE DE CRYPTOGAMIE
MUSÉUM NATIONAL D'HISTOIRE NATURELLE
12, RUE BUFFON, 75005 PARIS

PUBLICATION TRIMESTRIELLE

Novembre 1991

MANUSCRITS

Les recommandations aux auteurs sont publiées dans le premier fascicule de chaque tome. Les auteurs sont priés d'adresser leurs manuscrits (en trois exemplaires) au Directeur-Rédacteur de *Cryptogamie, Algologie*, Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, 12 rue Buffon, 75005 Paris.

Les tirages à part et les illustrations sont à la charge des auteurs.

ABONNEMENTS ANNUELS
Tome 12, 1991

CRYPTOGAMIE comprend trois Sections:
Algologie, Bryologie-Lichénologie, Mycologie.

Abonnement à l'une ou l'autre Section pour 1991:

France	(326 F ht)	332,85 F ttc
Étranger		357,00 F

Abonnement aux 3 Sections pour 1991:

France	(918 F ht)	937,28 F ttc
Étranger		1000,00 F

Prière de bien vouloir envoyer le montant par chèque bancaire ou par chèque postal libellé à l'ordre de : A.D.A.C. - CRYPTOGAMIE (CCP La Source 34 764 05 S), et adressé à:

A.D.A.C. - CRYPTOGAMIE
12, rue Buffon, F-75005 Paris.

Cryptogamie, Algologie est indexé par *Aquatic Sciences Fisheries Abstracts Part 1, Biological Abstracts, Chemical Abstracts, Current Contents, Marine Science Contents Tables (F.A.O.)*, Publications bibliographiques du CDST (Pascal).

CRYPTOGAMIE
ALGOLOGIE

TOME 12 Fascicule 4 1991

Anciennement REVUE ALGOLOGIQUE
Fondée en 1922 par P. ALLORGE et G. HAMEL
Directeur-Rédacteur : P. BOURRELLY
Éditeur : A.D.A.C.

SOMMAIRE

CRYPTOGAMIE, ALGOLOGIE

Tome 12 Fascicule 4 1991

CONTENTS

FIRST RECORD OF THE AUSTRAL SPECIES *PLOCAMIUM SECUNDATUM* (GIGARTINALES, RHODOPHYTA) FROM THE MEDITERREAN SEA

Mario CORMACI, Giovanni FURNARI and Donatella SERIO

Istituto e Orto Botanico dell'Università,
Via Longo 19, 95125 Catania, Italy.

ABSTRACT - The occurrence in the Mediterrean Sea of an austral species of *Plocamium, P. secundatum* (Kützing) Kützing, is reported. Mediterrean specimens show slight differences, as to Kützing's description and iconography, regarding the number of unilaterally arranged ramuli and stichidium features.

RÉSUMÉ - Les Auteurs signalent la présence en Méditerranée d'une espèce australe de *Plocamium: P. secundatum* (Kützing) Kützing. Les exemplaires méditerranéens diffèrent légèrement de la description et de l'iconographie de Kützing, soit par le nombre des ramules unilatéraux, soit par la morphologie de leurs stichidies.

KEY WORDS : *Plocamium secundatum*, Mediterranean Sea, geographic distribution.

INTRODUCTION

The genus *Plocamium* Lamouroux embraces some 35 species prevalently distributed in the southern hemisphere (Tab. I).

Most of them are endemic or show a restricted distribution area. Only *P. cartilagineum* (L.) Dixon has a cosmopolitan distribution and it is just this species the only up to now recorded from the Mediterrean Sea (Gallardo *et al.*, 1985; Ballesteros, 1990; Boudouresque, 1984; Perret-Boudouresque & Seridi, 1989; Furnari, 1984; Giaccone *et al.*, 1985; Ben Maiz *et al.*, 1987; Athanasiadis, 1987).

In the present account the occurrence in the Mediterrean Sea of another species of *Plocamium, P. secundatum* (Kützing) Kützing, is reported. This species up to now was reported only from Cape Horn (Kützing, 1849), Antarctica (Skottsberg, 1952), South Argentina (Kühnemann, 1969), Chile and Sub-antarctic Islands (Levring, 1960), Macquarie Island (Ricker, 1987).

MATERIALS AND METHODS

Both sterile and tetrasporic thalli were hand collected using SCUBA at Ognina (Catania, Italy) (Fig. 1) at 25 m depth in a community with *Cystoseira spinosa* Sauvageau.

All the observations were made on fluid preserved material. Herbarium specimens are held at the Botanical Institute of University of Catania.

The following material has also been studied: *Plocamium secundatum* (Kützing) Kützing, type material from Hermite Is. (Cape Horn), Rijksherbarium L 9140 n.1.

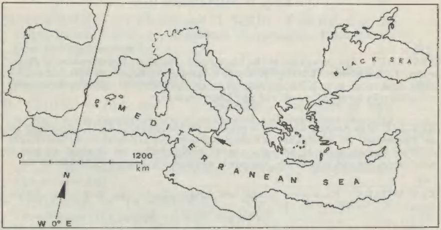


Fig. 1 - Map showing the locality of collection (arrow) of *Plocamium secundatum* (Kützing) Kützing in the Mediterranean Sea.

OBSERVATIONS

Thalli erect, to 4 cm high, irregularly ramified, with flattened main axes to 250 μm broad. Four-six ramuli in alternating series up to median parts of the axes, ten-fifteen unilaterally arranged in the apical parts, up to thirty-fourty in some specimens (Fig. 2) which show axes and ramuli incurved (Fig. 3). The lowermost ramuli are generally simple, while the others are alternately ramified near the base, unilaterally near the apex.

Stichidia are simple (Fig. 4) or branched 2-3 times (Fig. 5). The shortest straight, the longest, up to 450-480 μm long and 60-75 μm diameter, curved (Fig. 6). Tetrasporangia, zonately divided, are arranged in two rows. Spermatangia and cystocarps not observed.

DISCUSSION

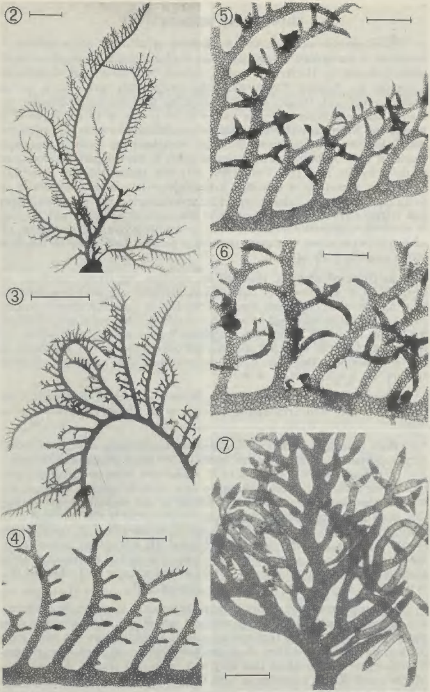
P. secundatum was described by Kützing (1849: 883) as a variety of *P. coccineum* Kützing (now *P. cartilagineum*). He based his description on specimens collected by Hooker at Hermite Island, N.W. Bay, near Cap Horn. Later, in his Tabulae Phycologicae, he treated this taxon as a species (Kützing 1866: vol. 16: tab. 42 c, d). According to Kützing's description, the main distinctive character of the species is the unilateral branching of both ramuli and their secondary branches. In our opinion, however, the predominantly unilateral arrangement of ramuli along axes is quite a distinctive character too. Although not mentioned either in the original description or in those by De Toni (De Toni, 1900: 591) and Mazza (Mazza, 1916-1922: 1543), it is illustrated in Kützing's iconography where a unilateral series up to 13 ramuli is drawn. Mazza *(op. cit.)* in specimens from Magellan Straits and Ricker's (1987) in specimens from Macquarie Island observed only up to 6 ramuli unilaterally arranged, while in the Mediterranean specimens 10-15 (up to 40 in some specimens showing a peculiar habit) can be observed in the terminal parts of axes.

As concerns stichidia, they are described as "squarroso-ramellosis vel dentatis" and illustrated as both oppositely and star-wise branched by Kützing *(op. cit.)*; oppositely branched, by Ricker *(op. cit.)*; cruciately, fan-wise and star-wise branched as well as individual, long and slightly hooked, by Mazza *(op. cit.)*. In the type specimen, however, simple as well as 1-2 times not oppositely branched stichidia are present too. In our specimens, as above mentioned, they are simple or branched 2-3 times, the shortest straight, the longest curved.

Moreover, some size variability is shown too; 6 cm in Kützing's; 4 cm in Mazza's and Mediterranean specimens; up to 13 cm in Ricker's specimens.

Both branching pattern and stichidium morphology are considered as very important features in the taxonomy of the genus *Plocamium* (Womersley, 1971; South & Adams, 1979). In *P. secundatum*, however, branching pattern, being consistent in all thalli up to now studied, appears the most significant character. The same cannot be said of the stichidium morphology that is rather various. The variability of this character is also reported from other species as *P. angustum* (J. Ag.) Hook. et Harv. and *P. cartilagineum* (South & Adams, *op. cit.)* from New Zealand. On this subject, it is interesting to record the occurrence of a new type of stichidial morphology (long and curved) observed in both old herbarium and recently field collected specimens of *P. cartilagineum* (Fig. 7) from Eastern Sicily.

Our specimens differ from *P. secundatum* only in inconsistent characters as the number of unilaterally arranged ramuli and the stichidium morphology (although in the type specimen some stichidia show the same morphology of ours) while they show the same habit and branching pattern. Therefore, we can conclude that they well fit to that species. As well, also Mazza's and Ricker's specimens well fit to *P. secundatum*, differing from Kützing's type only in inconsistent characters as: size, number of unilaterally arranged ramuli, stichidium morphology.


②
⑤
⑥
③
⑦
④

Finally, the occurrence of *P. secundatum* in the Mediterranean Sea raises interesting biogeographic questions. In fact, it is surprising that the first finding in the Northern hemisphere of an austral species of cold affinity occurs in the Mediterrean that, according to Lüning (1990), is a warm temperate sea. But, due to its spot distribution in that Sea, it seems too early to put forward any hypotheses on the causes of this disjunct distribution. Undoubtly, the above mentioned differences between austral and mediterranean specimens (number of unilaterally arranged ramuli; stichidial features), even if light, could let suppose an acclimatation process of a taxon which has been living in the Mediterranean Sea for a long time. On the other hand, the noticeable polymorphism of the species of the genus *Plocamium*, in addition to the above mentioned spot distribution, should be in accordance with a recent introduction of this species in the Mediterranean Sea.

ACKNOWLEDGEMENTS

We are grateful to the Curator of the Rijksherbarium for the loan of *Plocamium secundatum* (Kützing) Kützing. This work was supported by a grant from the Italian M.U.R.S.T.

REFERENCES

ATHANASIADIS A., 1987 - *A survey of the seaweeds of the Aegean Sea with taxonomic studies on species of the tribe Antithamnieae (Rhodophyta)*. University of Gothenburg, Dept. of Marine Botany, 174 p.

BALLESTEROS E., 1990 - Check list of benthic marine algae from Catalonia (North-western Mediterranean). *Treballs de l'Institut Botànic de Barcelona* 13: 5-52.

BEN MAIZ N., BOUDOURESQUE C.F. & OUAHCHI F., 1987 - Inventaire des algues et phanérogames marines benthiques de la Tunisie. *Giorn. Bot. Ital.* 121: 259-304.

BOUDOURESQUE C.F., 1984 - Groupes écologiques d'algues marines et phytocénose benthiques en Méditerranée nord-occidentale: une revue. *Giorn. Bot. Ital.* 118 (suppl. 2): 7-42.

DE TONI G.B., 1900 - *Sylloge algarum*. Vol. IV. Florideae. Sect. II, Fam. I-IV: 387-776. Padua.

FURNARI G., 1984 - The marine benthic algae of Southern Italy. Floristic and geobotanic considerations. *Webbia* 38: 349-369.

Figs 2-6: *Plocamium secundatum* (Kützing) Kützing. - Fig. 2: Peculiar habit of a specimen with up to 40 unilateral ramuli. - Fig. 3: Detail of a curved axis with unilateral ramuli. - Fig. 4: Detail of the thallus showing short and simple stichidia. - Fig. 5: Short and branched 2-3 times stichidia. - Fig. 6: Long and curved stichidia.

Fig. 7 - *Plocamium cartilagineum* (L.) Dixon: Detail of the thallus showing elongate, ramified and curved stichidia.
Bar = 2.5 mm (Figs 2-3); bar = 0.5 mm (Figs 4-7).

GALLARDO T.G., GOMEZ A.G., RIBERA M.A., ALVAREZ M.C. & CONDE F.P., 1985 - A preliminary checklist of Iberian benthic marine algae. *Real Jardin Botanico.* Madrid. 83 p.

GIACCONE G., COLONNA P., GRAZIANO C., MANNINO A.M., TORNATORE E., CORMACI M., FURNARI G. & SCAMMACCA B., 1985 - Revisione della flora marina di Sicilia e Isole minori. *Boll. Acc. Gioenia Sc. Nat.,* Catania 18: 537-781.

KÜHNEMANN O., 1969 - Vegetacion Marine de la Ria de Puerto Deseado. *Opera Lilloana,* Argentina XVII: 5-46.

KÜTZING F.T., 1849 - *Species algarum.* Lipsiae. 922 p.

KÜTZING F.T., 1866 - Tabulae Phycologicae. Vol. 16. Norhausen.

LEVRING T., 1960 - Contributions to the Marine Algal Flora of Chile. *Lunds Universitets Arsskrift.* N.F. Avd. 2. Bd 56 (10): 85 p.

LÜNING K., 1990 - *Seaweeds. Their environment, biogeography, and ecophysiology.* Wiley-Interscience Publ. New York. 527 p.

MAZZA A., 1916-1922 - *Saggio di algologia oceanica.* Vol. III: 1057-1584. Padova.

PERRET-BOUDOURESQUE M. & SERIDI H., 1989 - Inventaire des algues marines benthiques d'Algérie. *GIS Posidonie publ.,* Marseille, Fr.: 1-117.

RICKER R.W., 1987 - *Taxonomy and biogeography of Macquarie Island seaweeds.* British Museum (Nat. Hist.) 344 p.

SKOTTSBERG C., 1952 - On two collections of Antarctic Marine Algae. *Arkiv. för Botanik* 2: 531-566.

Tab. I - Geographic distribution and bibliography (numbers in brackets) of the species of the genus *Plocamium* Lamouroux. Synonyms in italics. Species marked with an asterisk are of uncertain taxonomic value.

P. angustatum (J. Agardh) Hooker et Harvey	- S. Australia and Tasmania (41);
P. abnorme Hooker et Harvey (37)	N. Zealand, Chatams Is.,
P. angustatum Kützing (37)	Stewart Is., Auckland Is (37);
P. botryoides Kützing (4)	Fiji Is. (4);
P. dispermum Harvey (37)	New Caledonia Is. (9)
P. gracile J. Agardh (37)	
P. beckeri Simons	- S. Africa (33)
P. brasiliense (Greville) Howe et Taylor	- North Carolina, the West Indies, Venezuela, Brazil (32, 42)
P. cartilagineum(Linnaeus) Dixon	- S. Australia and Tasmania (41);
P. angustum v. *pusillum*(Sonder) Harvey (13)	Senegal (19); from Bering Sea
P. binderianum Kützing (9)	to California, Iceland and N.
P. brachiocarpum Kützing (37)	Atlantic (31); S. Africa (33);
*P. californicum*Kützing (12)	Faeroes Is. (15); N. Sea (16);
P. coccineum (Hudson) Lyngbye (37)	Chile, S. Fernandez Is. (30);
P. coccineum f. *compactum* Collins (8)	Kent (39); Netherlands (38);
P. coccineum v. *pacificum* (Kylin) Dawson (14)	Norway (29); Antarctica (45).
P. coccineum v. *uncinatum* J. Agardh (34)	
P. cruciferum Harvey *in* Farlow (37)	
P. fenestratum Kützing (12)	
P. irregulare Meneghini (9)	
P. lynghyanum (9)	
P. mediterraneum Meneghini (9)	
P. pacificum Kylin (30)	
P. pusillum Sonder (41)	
P. subtile Kützing (9)	
P. uncinatum Kützing (9)	
P. vulgare Lamouroux (37)	
P. concinnum Areschoug	- Cape Vert Is. (9, 26).
P. biserratum Dickie (9)	
P. conferraceum Bory*	- Chile: Concepcion (37).
P. coccineum v.*confervaceum* Bory (18)	
P. corallorhiza (Turner) Harvey	- Cape of Good Hope (9); South
P. robertiae Schmitz ex Mazza (33)	Africa (33)
P. cornutum (Turner) Harvey	- Cape of Good Hope (9); Namibia
	(43); South Africa (33);
	Mauritius (2, 3)
P. costatum (C. Agardh) Hooker et Harvey	- S. Australia and Tasmania (41);
P. cunninghamii (Grev.) Hooker et Harvey (37)	New Zealand (37), the Philippines (36)
P. delicatulum Baardseth	- Tristan da Cunha (7).
P. dilatatum J. Agardh	- S. Australia and Tasmania (41).
P. froelichianum Kützing *	- Senegambia (9); Tasmania (11).
P. fuscorubrum Baardseth	- Tristan da Cunha (7).
P. glomeratum J. Agardh	- Cape of Good Hope (9); Namibia
P. affine Kützing (33)	(43); South Africa (33).
P. subfastigiatum Kützing (33)	
P. hamatum J. Agardh	- N. Zealand (37); Great Barrier
	(6); Norfolk and Cook Is. (5).
P. hookeri Harvey	- Kerguelen (9); South Orkney,
	South Georgia, Antarctica (27)
	Macquarie (28)

P. leptophyllum Kützing *P. coccineum* v. *flexuosum* J. Agardh (37) *P. flexuosum* (Hooker et Harvey) Sonder (41) *P. leptophyllum* v. *flexuosum* J. Agardh (24) *P. leptophyllum* v. *recurvatum* J. Agardh (9) *P. leptophyllum* v. *strictum* J. Agardh (9)	- S. Australia and Tasmania (41); Japan (44); New Zealand (37).
P. maxillosum (Poiret) Lamouroux *P. membraceum* Suhr (32)	- S. Africa (25, 33)
P. mertensii (Greville) Harvey *P. nidificum* Harvey ex J. Agardh (9) *P. procerum* (J. Agardh) Hooker et Harvey (9)	- S. Australia and Tasmania (41)
P. microcladioides South et Adams	- New Zealand (37); East Australia; Coffs Harbour (23)
P. minutum Levring	- Crozet Is. (7).
P. oregonum Doty	- From North Canada to California (13).
P. ovicorne Okamura *P. oviforme* Okamura (24)	- Japan (44).
P. patagiatum J. Agardh	- S. Australia and Tasmania (41).
P. patens Martens	- The Philippines (36).
P. preissianum Sonder *P. preissii* Kützing (22)	- S. Australia (41).
P. raphelisianum Dangeard	- Portugal, Spain, Morocco (1).
P. recurvatum Okamura	- Japan (10, 44).
P. rigidum Bory *P. condensatum* Kützing (33) *P. latiusculum* Kützing (33) *P. rigidum* v. *tenuior* Grunow (33) *P. robustum* Kützing (33)	- Cape of Good Hope (9); Namibia (43); South Africa (33).
P. sandvicense J. Agardh	- Hawai (21).
P. secundatum (Kützing) Kützing *P. coccineum* Hooker et Harvey (9) *P. coccineum* v. *australe* J. Agardh (9) *P. coccineum* v. *secundatum* Kützing (18)	- Magellan Straits (9); Chile, Falkland, S. Georgia, Kerguelen (20); S. Argentina (17); Palmer Archipelago, W. Antarctica (35); South Orkney, Macquarie (28).
P. serrulatum Okamura	- Japan (44); The Philippines (36, only the v. *pectinatum* Cordero)
P. suhrii Kützing *P. coccineum* v. *latiusculum* Kützing (9) *P. fullerae* Schmitz (33) *P. nobile* J. Agardh (33) *P. procerum* Suhr (33)	- S. Africa (33)
P. telfairiae (Hooker et Harvey) Harvey ex Kützing *P. abnorme* f. *uncinatum* Okamura (24)	- Mauritius (2); Ghana (19); S. Africa (33); Japan (24, 44); Tierra del Fuego (27); China, Korea, New Zealand, Australia, Tasmania, Pakistan, Mauritius (40); the Philippines (36).
P. violaceum Farlow *P. tenue* Kylin (31)	- From SW. Alaska to Mexico (13, 31); Chile (30).

Bibliographie

(1) ARDRÉ F., 1970 - Contribution à l'étude des Algues marines du Portugal. I. La flore. *Portugaliae Acta Biologica* (B) 10: 423 p.
(2) BÖRGESEN F., 1943 - Some Marine Algae from Mauritius. III Rhodophyceae. Part 2. Gelidiales, Cryptonemiales, Gigartinales. *Det Kongelige Danske Videnskabernes Selskab. Biologiske Meddelelser* 19: 1-85.
(3) BÖRGESEN F., 1953 - Some marine Algae from Mauritius. Additions to the parts previously published. V. *Det Kongelige Danske Videnskabernes Selskab. Biologiske Meddelelser* 21: 3-62.
(4) CHAPMAN V.J., 1971 - The marine Algae of Fiji. *Revue Algologique* 10: 164-171.
(5) CHAPMAN V.J., 1977 - Marine Algae of Norfolk Island and the Cook Islands. *Botanica Marina* 10: 161-165.
(6) CRIBB A.B., 1983 - *Marine Algae of the Southern Great Barrier Reef: Rhodophyta*. Australian Coral Reef Society. Handbook 2. 173 p.
(7) DAWSON E.Y., 1962 - New Taxa of Benthic Green, Brown and Red Algae Published Since De Toni, 1889, 1924, Respectively, as Compiled from the Dawson Algal Library. *Contribution from the Beaudette Foundation for Biological Research, Santa Ynez, California*. 105 p.
(8) DAWSON E.Y., ACLETO C. & FOLDVIK N., 1964 - The seaweeds of Perú. *Nova Hedwigia* 13: 111 p.
(9) DE TONI G.B., 1900 - *Sylloge algarum*. Vol. IV. Florideae. Sect. II. Fam. I-IV: 387-776. Padua.
(10) DE TONI G.B., 1924 - *Sylloge algarum*. Vol. VI. Florideae. Sect. V. Additamenta. 767 p.
(11) DE TONI G.B. & LEVI D., 1888 - *L'Algarium Zanardini*. Venezia. 144 p.
(12) FARLOW W.G., 1881 - *Marine Algae of New England and Adjacent Coast*. Washington: Government Printing Office. 197 p.
(13) GABRIELSON P.W. & SCAGEL R.F., 1988 - The marine algae of British Columbia, northern Washington, and southeast Alaska: division Rhodophyta (red algae), class Rhodophyceae, order Gigartinales, families Caulacanthaceae and Plocamiaceae. *Canadian Journal of Botany* 67: 1221-1234.
(14) HOLLENBERG G.J. & ABBOTT I.A., 1966 - *Supplement to Smith's Marine Algae of the Monterey Peninsula*. Stanford University Press, California (1969). 125 p.
(15) IRVINE D.E.G., 1982 - Seaweeds of the Faroes. *Bulletin of the British Museum (Natural History), Botany series* 10: 225 p.
(16) KORNMANN P. & SAHLING P.H., 1978 - Meeresalgen von Helgoland Benthische Grün-, Braun- und Rotalgen. *Biologische Anstalt Helgoland*, Hamburg. 289 p.
(17) KÜTZING F.T., 1849 - *Species algarum*. Lipsiae. 922 p.
(18) KÜHNEMANN O., 1969 - Vegetacion Marine de la Ria de Puerto Deseado. *Opera Lilloana*, Argentina XVII: 5-46.
(19) LAWSON G.W. & JOHN D.M., 1987 - The Marine Algae and Coastal Environment of Tropical West Africa (second edition). *Nova Hedwigia* 93: 415 p.
(20) LEVRING T., 1960 - Contributions to the Marine Algal Flora of Chile. *Lunds Universitets Arsskrift*. N.F. Avd. 2. Bd 56 (10): 85 p.
(21) MAGRUDER W.H. & HUNT J.W., 1979 - *Seaweeds of Hawaii*. The Oriental Publishing Company, Honolulu, Hawaii. 116 p.
(22) MAZZA A., 1905-1911 - *Saggio di Algologia Oceanica*. Vol. 1: 1-528. Padova.
(23) MILLAR A.J.K., 1990 - Marine Red Algae of the Coffs Harbour Region, Northern New South Wales. *Australian Systematic Botany: An Australian Journal of Scientific Research* 3: 293-593.
(24) OKAMURA K., 1933-1942 - *Icones of Japanese Algae*. Vol. VII: 116 p. + pls. 301-345 Tokyo.

(25) PAPENFUSS G.F., 1968 - Notes on South African Marine Algae. V. *Journal of South African Botany* 34: 267-287.
(26) PRUD'HOMME van REINE W.F. & LOBIN W., 1986 - Katalog der von den Kapverdischen Inseln beschriebenen Taxa von Algen (Algae: Chlorophyceae, Phaeophyceae & Rhodophyceae). *Cour. Forsch.-Inst.* Senckenberg 81: 85-88.
(27) PUJALS C., 1963 - Catalogo de Rhodophyta Citadas para la Argentina. *Revista del Museo Argentino de Ciencias Naturales "Bernardino Rivadavia" e Istituto National de Investigacion de las Ciencias Naturales.* Ciencias Botânicas 3: 139 p.
(28) RICKER R.W., 1987 - Taxonomy and biogeography of Macquarie Island seaweeds. British Museum (Nat. Hist.) 344 p.
(29) RUENESS J., 1977 - *Norsk Algeflora.* Universitetsforlaget, Oslo. 266 p.
(30) SANTELICES B., 1989 - *Algas Marinas de Chile. Distribucion, ecologia, utilización, diversidad.* Ediciones Universidad Católica de Chile. 399 p.
(31) SCAGEL R.F., GABRIELSON P.W., GARBARY D.J., GOLDEN L., HAWKES M.W., LINDSTROM S.C., OLIVEIRA J.C. & WIDDOWSON T.B., 1989 - *A synopsis of the Benthic marine algae of British Columbia, Southeast Alaska, Washington and Oregon. Phycological Contribution Number 3.* Department of Botany, University of British Columbia, Canada. 532 p.
(32) SCHNEIDER C.W. & SEARLES R.B., 1973 - North Carolina marine algae. II. New records and observation of the bênthic offshore flora. *Phycologia* 12: 201-211.
(33) SEAGRIEF S.C., 1984 - A Catalogue of South African Green, Brown and Red Marine algae. *Memoirs of the Botanical Survey of South Africa* 47: 72 p.
(34) SETCHELL W.A. & GARDNER N.L., 1903 - Algae of Northwestern America. *Bibliotheca Phycologica* 7: 419 p.
(35) SKOTTSBERG C., 1952 - On two collections of Antarctic Marine Algae. *Arkiv för Botanik* 2: 531-566.
(36) SILVA P.C., MEÑEZ E.G. & MOE R.L., 1987 - Catalog of the Benthic Marine Algae of the Philippines. *Smithsonian Contributions to the Marine Sciences* 7: 179 p.
(37) SOUTH G.R. & ADAMS N.M., 1979 - A revision of the genus *Plocamium* Lamouroux (Rhodophyta, Gigartinales) in New Zealand. *Phycologia* 18: 120-132.
(38) STEGENGA H. & MOL I., 1983 - *Flora van de Nederlandse Zeewieren.* Koninklijke Nederlandae Natuurhistorische Vereniging. 263 p.
(39) TITTLEY I. & PRICE J.H., 1977 - An atlas of the seaweeds of Kent. *Transactions of the Kent Field Club* 7: 80 p.
(40) TSENG C.K., XIA BANGMEI, XIA ENZHAN, ZHANG DERUI, ZHANG JUNFU, ZHENG BAILIN & ZHOU JINHUNA, 1983 - *Rhodophyta. In:* Common seaweeds of China. Ed. by C.K. Tseng, Science Press, Beijing, China: 43-161.
(41) WOMERSLEY H.B.S., 1971 - The genus *Plocamium* (Rhodophyta) in Southern Australia. *Trans. Real Soc. S. Aust.* 95: 9-27.
(42) WYNNE M.J., 1986 - A checklist of benthic marine algae of the tropical and subtropical western Atlantic. *Canadian Journal of Botany* 64: 2239-2281.
(43) WYNNE M.J., 1986 - Report on a collection of benthic marine algae from the Namibian coast (southwestern Africa). *Nova Hedwigia* 43: 311-355.
(44) YOSHIDA T., NAKAJIMA Y. & NAKATA Y., 1990 - Check-list of marine algae of Japan (revised in 1990). *The Japanese Journal of Phycology* 38: 269-320.
(45) ZANEVELD J.S., 1966 - The occurrence of benthic marine algae under shore fast-ice in the western Ross Sea, Antarctica. *Proceedings of the Fifth International Seaweeds Symposium. Halifax,* Canada: 217-231.

REDISCOVERY OF *BULBOCHAETE LONGIPES* BOURRELLY FROM INDIA

Pranjit SARMA and Jai PRAKASH KESHRI

Department of Botany, The University of Burdwan,
Burdwan - 713104, W.B. India

ABSTRACT - *Bulbochaete longipes* Bourrelly has been recorded from India and this is probably the only record of the species from outside Ivory Coast (West Africa), the original locality of its occurrence.

RÉSUMÉ - *Bulbochaete longipes* Bourrelly n'avait pas été retrouvé depuis sa découverte en Côte d'Ivoire (Afrique de l'Ouest); il vient d'être observé en Inde.

KEY WORDS : *Bulbochaete longipes*, new record, India.

INTRODUCTION

The genus *Bulbochaete* is represented in India by 38 taxa (Gonzalves, 1981). Recently 19 taxa of *Bulbochaete* have been reported from West Bengal among which more than a dozen of species are either new to science or new records for India (Sarma *et al.*, 1982, 1986, 1988; Kargupta & Sarma, 1987; Sarma & Mukherjee, 1985, 1990). While working on the freshwater algal flora of Midnapur district of West Bengal, the authors have come across this interesting and rare species of *Bulbochaete* (recorded after long 30 years of its original publication) among other species. This is one of the very few species of *Bulbochaete* where oospore does not fill the oogonium. This species was originally described by Bourrelly (1961) from tropical West Africa (Ivory Coast) and was later included in the African monograph on Oedogoniales by Gauthier-Lièvre (1963-64). It has not been reported yet from elsewhere. The present specimen in general tallies with the description given by Bourrelly (loc. cit.) but shows some additional features.

OBSERVATIONS

Bulbochaete longipes Bourrelly

Nannandrous, gynandrosporous; plant short, arcuate well branched; vegetative cells short cylindric-arcuate, 12 to 17 µm broad, 20 to 22 µm long with 3-6 pyrenoids per cell; basal cells conical, jointed with long delicate

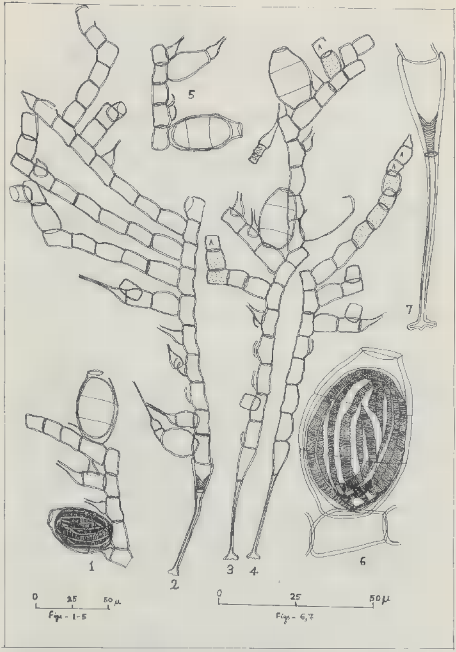


Fig. 1, 5: Part of plant body showing patent oogonia. Fig. 2, 4: General habit showing holdfast, nannandrium and androsporangia (A). Fig. 6: Ornamentation of the oospore. Fig. 7: Detail of the holdfast.

(3-4 μm broad) pedicellate extension ending in a lobed adhesive disc 10 μm in diameter, upper portion of the cone being 15-18 μm broad, wall of lower portion of conical basal cell distinctly lamellate; total length of basal cell (including the pedicellate extension 109 to 114 μm, oogonium directly born on the filament, ellipsoid, patent, 37 to 42 μm broad, 59 to 69 μm long; oospore ellipsoid, not filling the oogonium, 35 to 37 μm broad, 57 to 59 μm long; outer layer of spore wall thin, delicate and smooth, median layer thick with 8-12 strong costae with crenulate margin, furrows between costae astriated; androsporangia 12 to 17 μm broad, 15 to 22 μm long; dwarf males near oogonia, 49 μm (inluding antheridia) long; stipe elongate, slightly curved, 12 μm broad; antheridium 9 to 10 μm broad, 10 to 12 μm long, exterior and seriate (two).

Coll. No. JPK 352, dated 3.11.88, collected from Dogachia, District Midnapur (West Bengal) growing attached on aquatic grass in a pond, pH 6, temp. 32°C at 11 a.m.

TAXONOMIC CONSIDERATIONS

The present Indian specimen differs from the original one of West Africa in having well branched plant body, larger oogonia, oospores and nannandria, and distinctly seriate antheridia on dwark male stipe. Additional features observed in the present specimen are: conical basal cell jointed with a long and delicate pedicellate extension ending in a lobed adhesive disc, distinctly crenulate costae on the median wall of oospore and the gynandrosporous nature.

ACKNOWLEDGEMENTS

The authors wish to thank the Head of the Department of Botany, Burdwan University for providing laboratory facilities and J.P.K. is grateful to the University Grants Commission, New Delhi for the award of a research fellowship.

REFERENCES

BOURRELLY P.*, 1961 - Algues d'eau douce de la République de Côte d'Ivoire. *Bull. Inst. Franç. Afrique Noire* Sér. A. 23 (2): 283-374, 24 pl.

GAUTHIER-LIÈVRE L., 1963-1964 - Oedogoniacées Africaines. *Nova Hedwigia* 6-7: 151-481; 545-558.

GONZALVES E.A., 1981 - *Oedogoniales.* Indian Council of Agricultural Research, New Delhi. 757p.

KARGUPTA A.N. & SARMA P., 1987 - Rare species of *Bulbochaete* (Chlorophyceae: Oedogoniales) from Birbhum and Murshidabad districts of West Bengal, India. *Hydrobiologia* 153: 13-21.

SARMA P., MUKHERJEE D.D. & MUSTAFA G., 1982 - On two new taxa of nannandrous *Bulbochaete* from West Bengal (Abstr.). *Proc. 69th Indian Sci. Congr.* Pt. 3: 11.

* Original not seen.

SARMA P. & MUKHERJEE D.D., 1985 - A new species of *Bulbochaete* from West Bengal, India. *Acta Phytotax. Sin.* 23 (4): 317-319.

SARMA P., MUKHERJEE D.D. & CHAKRABARTY A.K., 1985 - On the occurrence of two new taxa of nannandrous *Bulbochaete* from West Bengal, India (Abstr.). *Proc. 72nd Indian Sci. Congr.* Pt. 3: 6.

SARMA P., MUKHERJEE D.D. & CHAKRABARTY A.K., 1986 - New records of *Bulbochaete* species (nannandrous) from West Bengal, India (Abstr.). - *Proc. 73rd Indian Sci. Congr.* Pt. 3: 15.

SARMA P., MUKHERJEE D.D. & CHAKRABARTY A.K., 1988 - New record of nannandrous *Bulbochaete* (Oedogoniales: Chlorophyta) from West Bengal, India. *Nova Hedwigia* 47 (1-2): 255-267.

SARMA P. & MUKHERJEE D.D., 1990 - A new species of macrandrous heterothallic *Bulbochaete* (= *B. iyengarii* sp. nov.) from West Bengal, India. *In* RAJA RAO V.N. (Ed.), *Perspectives in Phycology* (Prof. M.O.P. Iyengar Centenary Celebration Volume). Today and Tomorrow's Printers & Publishers, New Delhi, pp. 55-57.

THE EFFECT OF LIGHT REGIME ON THE PHOTOSYNTHETIC APPARATUS OF THE FRESHWATER RED ALGA *BATRACHOSPERMUM BORYANUM*

Donald KACZMARCZYK and Robert G. SHEATH*

Department of Botany, University of Rhode Island,
Kingston, R.I. 02881, U.S.A.
*Present address: Department of Biology, Memorial
University of Newfoundland, St. John's,
Newfoundland, Canada A1B 3X9

ABSTRACT - Total irradiance appeared to control most pigment alterations in the freshwater red alga *Batrachospermum boryanum*. The only exception was a relative increase of phycoerythrin compared to phycocyanin in response to enhanced levels of green light under a natural tree canopy. However, this apparent complementary chromatic acclimatation was not confirmed by tests with color filters, either *in situ* or *in vitro*. Phycocyanin to phycoerythrin ratios tended to decrease as irradiance increased in laboratory studies. Phycobilisome size was greater in low light, field-acclimated plants. Average spacing between phycobilisomes was greater in high-light field populations. Photosynthesis in *B. boryanum* was negatively correlated to the phycocyanin to phycoerythrin ratio. Photosynthetic action spectra demonstrated a broad response to wavelength such that the alga was equally productive over most of the visible spectrum. This was also shown in the photosynthetic rates of plants grown under different wavelengths in the laboratory, where significant differences were not observed under either red, green, blue or neutral filters of equal light quantity.

RÉSUMÉ - L'irradiance globale a semblé contrôler la plupart des altérations pigmentaires de l'algue d'eau douce *Batrachospermum boryanum*. L'accroissement relatif de la phycoérythrine par rapport à la phycocyanine aux niveaux croissants de lumière sous une voûte d'arbres naturelle apparaît comme une exception. Cependant, des études avec les filtres colorés n'ont pas confirmé, ni *in situ* ni *in vitro*, ce qui semblait être une adaptation chromatique complémentaire. Dans les expériences de laboratoire la proportion de la phycoérythrine à la phycocyanine ainsi que les unités photosynthétiques avaient tendance à décroître au fur et à mesure que l'irradiance augmentait. Les plantes ayant poussé sous peu de lumière sur le terrain, possédaient une densité élevée de phycobilisomes. L'espacement moyen entre les phicobilisomes était plus grand parmi les populations existant dans des terrains à haute intensité lumineuse. Il y avait une corrélation négative entre la photosynthèse de *B. boryanum* et la proportion de la phycocyanine à la phycoérythrine. Le spectre d'action photosynthétique a démontré que l'algue était également productive dans la plupart du spectre visible. Ce phénomène se voyait aussi dans la vitesse de croissance des plantes cultivées en laboratoire sous des longueurs d'ondes différentes; des différences significatives n'étaient pas observées sous des filtres rouges, verts, bleus, ou neutres à flux lumineux identiques.

KEY WORDS : *Batrachospermum boryanum*, freshwater Rhodophyta, photoacclimation, phycobiliproteins.

INTRODUCTION

Studies on marine rhodophytes growing at various depths or using color mutants have indicated that light quantity alone affects pigments content (Dring, 1981; Ramus & van der Meer, 1983). However, in the freshwater environment, Thirb & Benson-Evans (1983) reported that alterations in pigment content and photosynthetic rates in *Lemanea sp.* occurred in response to changes in both light quantity and quality. It is clear that more taxa and additional environments need to be studied before it can be stated unequivocally that chromatic acclimatation does not occur in the Rhodophyta. This is particularly true since this phenomenon has been shown to take place in the Cyanophyta (e.g. MacColl & Guard-Friar, 1987).

Acclimation to total illumination in red algae typically involves increases in pigment content at lower irradiances. Little is known as to whether this involves changes in phycobilisome size or number (Gantt, 1990). Waaland *et al.* (1974) observed decreases in the number of phycobilisomes in *Griffithsia* at higher irradiance levels. Whether photoacclimation by change in phycobilisome number is universal in the Rhodophyta needs to be corroborated.

Batrachospermum boryanum Sirodot is a common inhabitant of temperate stream systems (Sheath & Burkholder, 1985) and, like many freshwater red algae, it is blue-green in color due to a relatively high level of phycocyanin (Honsell *et al.*, 1984). Rhodophyta growing in streams are frequently subjected to shading by over-hanging leaf canopy which results in significant seasonal variations in light quantity and quality. As the canopy becomes more dense, blue and red light decrease relative to other wavelengths (Federer & Tanner, 1966). This differs from the coastal marine environment which is usually enriched in green light and does not change appreciably over time (Ramus & van der Meer, 1983). Since most prior studies on chromatic acclimation have used marine red algae, the light conditions present in streams provide an excellent expansion of the photic conditions affecting pigment content and photosynthetic rates.

MATERIALS AND METHODS

Part I - Field studies 1987 and 1988

To establish different photoregimes in the field, a plexiglas chamber was designed after a model used by Triska *et al.* (1983): 1 m x 60 cm x 10 cm. It was divided equally into six, 10 cm wide chutes. The chutes allowed a uniform flow over the plants and manipulation of light quantity and quality.

The sites studied were situated in the Pawcatuck River drainage basin to ensure similar physico-chemical parameters other than light (Sheath &

Burkholder, 1985). Two plexiglas chambers were placed at each site. The open site was located on Chickasheen Brook in South Kingstown, R.I., U.S.A. (41°29′15″N, 71°32′45″W). The open site chambers were divided into five different sectors. One sector was left as an open control. The other four sectors had equal reduction of total irradiance to 15% of the open control: neutral density wire screen, red (peak 671 nm), green (peak 532 nm), or blue (peak 488 nm) acetate (Table II). The position of the various light sectors in each plexiglas chamber was determined by random selection.

Table I - Relative light energy at six different wavelengths over the course of the field studies. - Canopied Site. (Values are standardized to the means).

Wavelength (nm)	February	March	April	May	June
410 (violet)	0.95	1.07	1.05	1.02	1.00
488 (blue)	1.26	1.34	1.26	1.15	1.00
532 (green)	1.16	1.16	1.16	1.28	1.33
570 (yellow)	0.95	0.90	0.89	1.02	1.00
625 (orange)	0.95	0.81	0.89	0.89	1.00
671 (red)	0.74	0.72	0.74	0.64	0.67

Table II - Relative energy at six different wavelengths over the course of the field studies. - Filter tests at open site. (Values are standardized to the means).

Wavelength (nm)	Red	Green	blue	Neutral	Open Control
410 (violet)	0.00	0.00	0.29	0.97	1.01
488 (blue)	0.00	1.50	3.77	1.28	1.28
532 (green)	0.00	3.12	1.84	1.19	1.17
570 (yellow)	0.14	1.04	0.10	0.93	0.92
625 (orange)	2.73	0.00	0.00	0.88	0.89
671 (red)	3.14	0.35	0.00	0.75	0.73

The experiment began in early March and continued through the end of May 1987 and then was repeated from March to June 1988. This included the period of peak biomass for *Batrachospermum boryanum* (Sheath & Burkholder, 1985). Samples of *B. boryanum* were collected in triplicate at three-week intervals from all light sectors. A three-week period is more than adequate since light acclimation typically takes only several cell divisions (Levy & Gantt, 1988). The plants were promptly taken to the laboratory at each sampling for analysis.

Pigment analysis was performed according to the methods of Siegelman (pers. comm.). The samples were ground in liquid nitrogen, suspended in 0.055 M potassium phosphate buffer (KPi), 0.2 M NaCl (pH 6.8) and centrifuged at 10000 g for 5 min at 4°C. The raw phycobiliprotein extract (supernatant) was collected, the pellet was ground again and the procedure was repeated until no visible color remained in the supernatant. After extraction of phycobiliprotein pigments, the pellet was then resuspended in 90% acetone saturated with $MgCO_3$. Centrifugation was repeated and the chlorophyll *a* (chl *a*) extract (supernatant) was collected. The phycobiliprotein and chl *a* fractions were quantified using a spectrophotometer (Varian -

Model DMS-90). Equations and extinction coefficients were given by Siegelman & Kycia (1978).

Midday measurements of light quantity and quality were taken first through each of the various light screens at the open site on a sunny day and a cloudy day. A spectroradiometer (Biospherical - Model Mer-1010A) was used to measure light at six wavelengths: 410 nm (violet), 488 nm (blue), 532 nm (green), 570 nm (yellow), 635 nm (orange) and 671 nm (red). Light readings were then recorded at both the open and canopied streams at six different points at each site and three points along the length of each chamber (Tables I and II).

Measurements were taken near midday at the middle of each month on sunny days from September of 1987 through August of 1988. By combining meteorological data (% cloudiness and daylenght, National Weather Service - Warwick, R.I., U.S.A.) with actual light measurements at the stream sites, it was possible to obtain estimates of the total energy received by the plants in (mol m^{-2} d^{-1}) for both years of the field study (Table III and IV).

Table III - Total pigment content (mg g^{-1} fw), phycocyanin to phycoerythrin and phycobiliprotein to chlorophyll *a* ratios and light energy received by plants (mol m^{-2} d^{-1}) in 1987 and 1988 field studies.

Date	Energy	Total pigment	PC/PE	PBP/chl *a*
1987 - Canopied Site				
(3/25)	13.3	0.191	1.3	1.6
(4/16)	24.4	0.295	1.0	1.6
(5/4)	5.0	0.619	0.8	0.6
(5/27)	1.7	0.700	0.6	0.7
1988 - Canopied Site				
(3/30)	13.3	0.363	1.1	1.7
(4/18)	5.0	0.218	1.0	1.7
(5/18)	5.0	0.175	0.9	0.5
(6/1)	1.7	0.341	0.7	0.6
1987 - Open Site				
(3/25)	43.3	0.095	1.0	1.3
(4/16)	48.1	0.093	1.0	0.3
(5/4)	48.3	0.332	0.9	0.3
(5/27)	49.5	0.120	1.1	0.5
1988 - Open Site				
(3/30)	45.5	0.154	0.9	0.8
(4/18)	49.9	0.124	0.9	0.7
(5/18)	58.8	0.138	0.9	0.5
(6/1)	47.3	0.136	1.1	0.4

Table IV - Total pigment content (mg g^{-1} fw), phycocyanin to phycoerythrin and phycobiliprotein to chlorophyll *a* ratios and light energy received by plants (mol $m^{-2}d^{-1}$) in 1987 and 1988 field studies. (Filter tests at open site).

Date	Energy	Total pigment	PC/PE	PBP/chl *a*
1987 - Blue filter (Maximum transmittance - 488 nm)				
(3/25)	6.5	0.108	0.8	0.6
(4/16)	7.3	0.134	0.7	0.3
(5/4)	7.3	0.336	1.1	0.3
(5/27)	7.5	0.173	1.0	0.3
1988 - Blue Filter				
(3/30)	6.8	0.274	1.1	1.0
(4/18)	7.5	0.350	0.9	0.6
(5/18)	8.8	0.170	0.9	0.6
(6/1)	7.1	0.194	1.2	0.5
1987 - Red filter (Maximum transmittance - 671 nm)				
(3/25)	6.5	0.075	1.0	1.1
(4/16)	7.3	0.081	0.7	0.5
(5/4)	7.3	0.366	1.0	0.3
(5/27)	7.5	0.217	0.9	0.1
1988 - Red Filter				
(3/30)	6.8	0.290	1.1	1.7
(4/18)	7.5	0.251	0.7	0.6
(5/18)	8.8	0.175	1.0	0.5
(6/1)	7.1	0.217	1.3	0.6
1987 - Green Filter (Maximum transmittance - 532 nm)				
(3/25)	6.5	0.110	0.9	1.1
(4/16)	7.3	0.168	1.0	0.7
(5/4)	7.3	0.349	0.9	0.3
(5/27)	7.5	0.219	0.8	0.3
1988 - Green Filter				
(3/30)	6.8	0.162	0.9	1.5
(4/18)	7.5	0.171	0.8	0.7
(5/18)	8.8	0.150	1.0	0.5
(6/1)	7.1	0.184	1.1	0.3
1987 - Neutral Filter				
(3/25)	6.5	0.120	0.9	0.7
(4/16)	7.3	0.186	0.7	0.3
(5/4)	7.3	0.314	0.8	0.3
(5/27)	7.5	0.191	0.8	0.3
1988 - Neutral Filter				
(3/30)	6.8	0.316	0.9	0.9
(4/18)	7.5	0.238	0.9	0.3
(5/18)	8.8	0.224	0.6	0.3
(6/1)	7.1	0.220	1.0	0.3

Differences in means between populations were calculated based on the following: phycocyanin content (PC), phycoerythrin (PE), allophycocyanin (APC), chl *a*, PC/PE and total phycobiliproteins to chl *a* (PBP/chl *a*). A one-way analysis of variance (ANOVA) was performed using the Minitab computing system (Ryan *et al.*, 1976). Pearson-product moment correlations were calculated between total light energy received or the relative amount of green light and each of the various pigment parameters.

Part II - Lab Studies

A. Light saturation curves and photosynthetic action spectra for low and high light-acclimated populations of B. boryanum

Field samples of *B. boryanum* were collected from two different sites along the Chipuxet River. One of these was the canopied site used in the 1987 and 1988 field studies. At the time of collection, it had approximately 30% light transmitted at the streams surface relative to an open area immediately adjacent the stream (designated "low light"). The other site was located in South Kingstown, R.I. (41°28'45"N, 71°33'0"W) and had approximately 60% light transmitted at the stream surface ("high light").

All plants collected from the field were cleaned of epiphytes and debris and were transferred to Bold's Basic Medium (BBM). Photosynthetic rates were then obtained (mg O_2 min^{-1} g^{-1} fw) using an oxygen meter (Orbisphere - Model 2607). Oxygen readings were taken for 20 min light and 5 min darkness in order to obtain values for gross photosynthesis. Linearity of the readings was determined prior to the actual measurements. The light sources used were 122 cm, 40 Watt, wide spectrum fluorescent bulbs. Total irradiance was ajusted by applying layers of white mesh cloth to the outside of the glass vessels. The range of irradiances was 0 to 400 μmol m^{-2} s^{-1} and three replicate samples were used for both the high and low light-acclimated plants. Temperatures were maintained at 10°C.

Action spectra were run at a non-saturating irradiance of 20 μmol $m^{-2}s^{-1}$ based on methods of Dring (pers. comm.). Nineteen narrow band interference filters (Oriel) were used, ranging from 402 nm (violet) to 701 nm (red). The light source was a 24 V, 150 W Tungsten Halogen Lamp (Bell and Howell). The oxygen meter (Model 781-b-Strathkelvin) was linked to a microcomputer (BBC Master Series). A variable transformer (Zenith) was connected to the light source projector to ajust light to equivalent photon fluxes for each color filter used. The temperature was maintained at 10°C by using a water bath. Values for gross photosynthesis in replicates of four or five were obtained by using 15 min light periods, followed by 10 min of darkness for each of the nineteen wavelengths.

B. Pigment analysis and photosynthesis in B. boryanum acclimated to different light quantities and qualities

In the spring of 1989, samples of *B. boryanum* were collected from the canopied stream section of the Chipuxet River that was used for the field studies. The plants were transferred into 200 ml of BBM. Plants were acclimated for six weeks to seven different light regimes: 2.2, 4.8, 13.6 and 28.1

mol m^{-2} d^{-1} (25, 55, 155 and 320 μmol m^{-2} s^{-1}) white light and three different light qualities at 4.8 mol m^{-2} d^{-1} (55 μmol m^{-2} s^{-1}). The light quality regimes were established with colored cellophane as follows: red (peak 671 nm), green (532 nm) and blue (410-488 nm) (Table V). There were three replicate glass vessels for each light condition. Light measurements and pigment analyses were performed as outlined earlier after a six-week interval. Photosynthetic rates were obtained for all samples as outlined in Part II-A, in attempt to relate photosynthesis to pigmentation. Differences in pigment content and gross photosynthesis were tested among the conditions with ANOVA. Similarly, relative correlations were done as described earlier.

Table V - Relative light energy at six different wavelengths. (Lab. study). - (Values are standardized to the means).

Wavelength (nm)	Red	Green	blue	Neutral	Open Control
410 (violet)	0.00	0.54	2.48	0.85	0.85
488 (blue)	0.00	0.82	1.43	0.64	0.64
532 (green)	0.00	1.91	1.04	0.81	0.80
570 (yellow)	0.00	1.09	0.52	0.99	0.96
625 (orange)	1.80	0.82	0.26	1.69	1.73
671 (red)	4.20	0.82	0.26	1.02	1.04

Part III - Electron microscopy

Samples of *B. boryanum* were collected from the open and shaded stream segments that were used in Part II-A and fixed in 2.5% glutaraldehyde in 0.1 M sodium cacodylate buffer (pH 7.2), post fixed in 1% osmium tetroxide, dehydrated in a standard ethanol/propylene oxide series and embedded in Spurr's medium. The specimens were sectioned with a LKB-III ultramicrotome and stained with 5% uranyl acetate for 20 min and Reynolds lead citrate for 8 min. Fascicle cell chloroplasts were photographed with an electron microscope (JEOL - 12000 EX STEM) at 60,000 x magnification in replicates of ten. Measurements were made of phycobilisome diameter, spacing between adjacent phycobilisomes (taken from the center of each) and for spacing between thylakoid membranes. Averages and statistical differences were determined using ANOVA as stated previously.

RESULTS

Part I - Field studies 1987 and 1988

The open site had significantly higher irradiance values than the canopied site throughout the year (Fig. 1). All statistical differences in the field study were at the 95% confidence level unless otherwise noted. Variations between the sites were much greater when the leaf canopy was present from May to October. The maximum difference was approximately 1970 μmol m^{-2} s^{-1}. In contrast, the difference between the two sites in the month of February was only about 750 μmol m^{-1} s^{-1}. Peak irradiance occurred at the canopied site in April (ca. 800 μmol m^{-2} s^{-1}) just before the leaf canopy reappeared. The relatively small peaks seen at both sites in January (ca. 1850

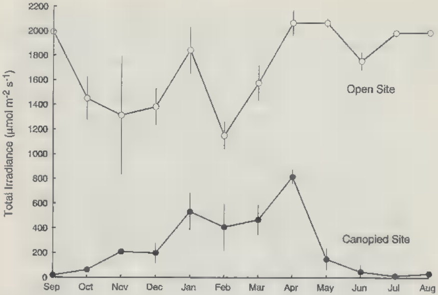


Fig. 1. - Total irradiance vs month at canopied and open sites (Error Bars = 1 standard deviation).

μmol m^{-2} s^{-1} at the open site and 530 μmol m^{-1} s^{-1} at the canopied site) were associated with increased light reflectance due to snow cover (Fig. 1).

The relative proportion of various light wavelengths did not change significantly through the year at the open site. However, at the canopied site there were significantly higher levels of green light and lower levels of red and blue light at the time of leaf canopy presence (Table I). In contrast, from February through April, the relative proportion of each wavelength approximated the values at the open site. For example, standardized values for green light rose from approximately 1.16 to 1.33 from April to June after remaining constant at 1.16 from February to April.

The total energy received by the plants (in mol m^{-2} d^{-1}) increased significantly over the course of the experimental period at the open site only in 1987 (Table III). In constrast, significant reductions were observed at the canopied site in late spring, when the leaves developed in both years. Energy estimates under the various light quality filters at the open site approximated values taken at the canopied site under developing leaves (April 16 to May 4, 1987) and (April 18 to May 18, 1988) (Tables III and IV).

Total pigment levels fluctuated throughout the experimental period in both the canopied and open site populations. These levels were significantly higher at the canopied site for most sampling times. Total pigment levels ranged from 0.075 to 0.700 mg/g fw for all samples (Tables III and IV). These relatively low values were due to the low dry wt./fresh ratio in *B. bor-*

yanum (c.f. 0.02) (Hambrook, pers. comm.). The PBP/chl *a* ratio was generally higher at the canopied site than at the open control, but it was significantly higher only on April 16 (1.6 to 0.3) and May 27 (0.7 to 0.5) in 1987 (Table III). This ratio decreased as total light increased in the open control samples for both years. In 1987 the mean ratios declined from 1.3 (March 25) to 0.5 (May 27). In 1988 the decline was from 0.8 (March 30) to 0.5 (June 1). Over the same period of time, total light at the open site increased from 43.3 to 49.9 mol m^{-2} d^{-1} in 1987 and from 45.5 to 47.3 in 1988. The negative correlation between the two variables was significant ($p < 0.01$) only in 1987. At the canopied site the PBP/chl *a* ratio decreased as total light declined, but the correlation was not significant in either year. In addition, the PBP/chl *a* ratio was negatively correlated to the relative amount of green light at this site but the correlation was significant only in 1988 (Tables I and III).

In 1987 total pigment content in the color filter tests peaked in all of these groups on May 4 and declined thereafter and the PBP/chl *a* ratios decreased over time (Table IV). In 1988 total pigment content peaked at different times in the various color tests. There was a general decline in the PBP/chl *a* ratio as in 1987. However, this ratio decreased significantly over time in most sample groups at each site for both years (Tables III and IV).

In both years of the field study the relative levels of PE and PC were either nearly equal or PC was slightly dominant at the beginning of the study (March 25 in 1987 and March 30 in 1988) (Table III). In the open control these pigment levels remained similar throughout the experimental period. In contrast, PE increased significantly compared to PC as the relative proportion of available green light increased under the tree canopy (Tables I and III). In 1987 the mean PC/PE ratio declined from 1.3 (March 25) to 0.6 (May 27). In 1988 the ratio declined from 1.1 (March 30) to 0.7 (June 1). Over the same period of time the relative amount of green light increased from 1.16 to 1.33 (Table I). There was a significant negative correlation between green light at the canopied site and the PC/PE ratio for both 1987 and 1988 ($p < 0.05$-0.01). No such correlation was observed at the open site. The correlation between total light energy (mol m^{-2} d^{-1}) and the PC/PE ratio at the canopied site was not significant in either year (Table III).

In the experimental light regimes at the open site, the relative levels of PE and PC fluctuated between PE and PC dominance (Table IV). APC consistently was significantly lower concentrations than the other pigments.

Part II - Lab Studies

A. Light saturation curves and photosynthetic action spectra for low and high light-acclimated populations of B. boryanum.

High light-acclimated plants had significantly greater gross photosynthetic rates than low light plants over the full range of irrandiances tested ($p < 0.05$). Maximum photosynthetic rates in the high and low light groups were 22.2 mg O_2 min^{-1} g^{-1} fw and 8.0 mg O_2 min^{-1} g^{-1} fw, respectively. Light saturation occurred at an irradiance of ca. 250 μmol $m^{-2}s^{-1}$ in both groups (data not shown).

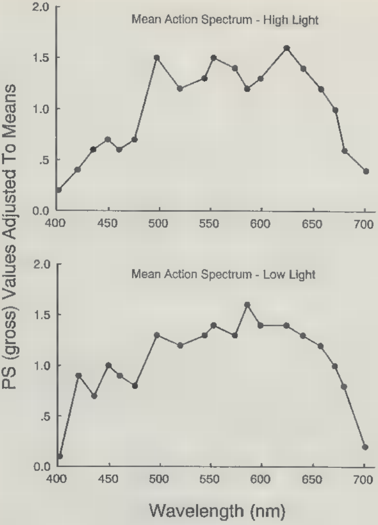


Fig. 2. - Mean photosynthetic action spectra for high and low light field-acclimated populations of *B. boryanum*.

The action spectra were not significantly different ($p < 0.05$) between high and low light-acclimated plants (Fig. 2). Maximum photosynthesis occurred over a broad range in the middle of the visible spectrum and significant differences between rates were seen only at each end of the spectrum. In the high light plants, the photosynthetic rates at wavelengths between 544 nm and 553 nm (green) and between 599 nm and 671 nm (orange-red), were significantly higher and those between 402 nm and 435 nm (violet-

blue), 475 nm (blue) and 680 to 701 nm (red). In the low light plants, photosynthetic rates between 553 nm and 624 nm (green-orange) were significantly higher than those between 402 nm and 435 nm (violet-blue) and at 701 nm (red).

B. Pigment analysis and photosynthesis in B. boryanum acclimated to different light quantities and qualities

Pigment contents of *B. boryanum* plants acclimated to different light quantities and qualities in the laboratory were not significantly different ($p < 0.05$) in terms of PE, PC, APC or chl *a* under the different light regimes. Plants from the first (2.2 mol $m^{-2}d^{-1}$) (25 μmol $m^{-2}s^{-1}$), Neutral group has a significantly higher PC:PE ratio than those from the fourth (28.1 mol $m^{-2}d^{-1}$) (320 μmol $m^{-2}s^{-1}$). Neutral group (1.4 to 0.8) and there was a significant negative correlation between the PC:PE ratio and total energy received in the four different irradiance groups (table VI). Total energy received by the plants (mol $m^{-2}d^{-1}$) was in the range of values obtained for the canopied site *in situ* (Tables III and VI).

Table VI - Total pigment content (mg g^{-1} fw), phycocyanin to phycoerythrin and phycobiliprotein to chlorophyll *a* ratios and light energy received by plants (mol m^{-2} d^{-1}). (Lab. study - 6 week time interval).

Condition	Energy	Total Pigment	PC/PE	PBP/Chl *a*
Blue	4.8	0.169	1.3	0.9
Red	4.8	0.185	1.4	1.1
Green	4.8	0.123	1.5	1.9
Neutral (1)	2.2	0.181	1.4	0.9
Neutral (2)	4.8	0.221	1.3	0.9
Neutral (3)	13.6	0.109	1.0	1.4
Neutral (4)	28.1	0.084	0.8	0.5

Photosynthetic rates were greater at the higher acclimation irradiances (range 1.02-3.06 mg O_2 $min^{-1}g^{-1}$ fw and 10.0 to 60.7 mg O_2 min^{-1} mg^{-1} total pigments for Neutral (1) and Neutral (4), respectively). The rates did not vary significantly among plants acclimated to different light qualities at 4.8 mol $m^{-2}d^{-1}$ (55 μmol m^{-2} s^{-1}) but the following trends were observed: green light acclimated plants had higher photosynthetic rates that blue light plants (2.0 to 1.0 mg O_2 $min^{-1}g^{-1}$ fw and 16.2 to 8.9 mg O_2 min^{-1} mg total pigment). Likewise, green light acclimated plants had higher photosynthetic rates than red light plants whose rates were 1.5 mg O_2 $min^{-1}g^{-1}$ fw and 8.1 mg O_2 min^{-1} mg^{-1} total pigment. Photosynthesis was negatively correlated to the PC/PE ratio in all seven of the different light quantity and quality groups. The PC/PE ratio ranged from 0.83 to 1.46, while photosynthesis ranged from 1.0 to 3.1 mg O_2 $min^{-1}g^{-1}$ fw and 5.6 to 38.0 mg O_2 min^{-1} mg^{-1} total pigments.

Part III - Electron microscopy

In situ populations of *B. boryanum* at the canopied site had a significantly larger ($p < 0.05$) mean phycobilisome diameter (29 nm) than did

those in the open site (26 nm). Average spacing between adjacent phycobilisomes was significantly greater in the open samples (83 nm) compared to the shaded ones (69 nm). Mean spacing between the thylakoid membranes was 84 nm for open plants and 62 nm for those at the canopied site. However, this difference was not significant.

DISCUSSION

Despite seasonal increases at the canopied site, the percentage of green light never approached that of the coastal marineenvironment (ca. 40%) (Dring, 1981). The proportion of green wavelengths under the tree canopy was also relatively low when compared to the artificial green regime at the open site. Nevertheless, the small increases in green light and decreases in red and blue light which occurred at the shaded site were in accord with findings of Federer & Tanner (1966) who observed energy maxima in the green and minima in the red under various types of plant canopies. There was essentially neutral filtering of branches at the shaded site in winter.

The negative correlation between the relative amount of green light and the PC/PE ratio observed at the canopied site appears to represent chromatic acclimation (Bogorad, 1975), a process that has not yet been conclusively shown to occur in the Rhodophyta (Gantt, 1990; Ramus, 1983). In *B. boryanum*, the specific phycobiliprotein pigment types present include R-PE, R-PC and allophycocyanin (Gantt, pers. comm.). Isolated R-PE has an absorbance at 532 nm that is more than two times greater than the absorbance of R-PC at the same green wavelength (MacColl & Guard-Friar, 1987). Therefore, an increase in PE relative to PC is ecologically advantageous under conditions where green light is enriched. However, much of the evidence from the field studies did not support chromatic acclimation in *B. boryanum* as follows: 1) similar changes among the artificial light quality tests at the open site; and 2) decline in the PBP/chl *a* ratio over time in most sample groups, regardless of light regime. It is possible that the phycobiliproteins were utilized as a nitrogen source for metabolism, particularly in the older populations (MacColl & Guard-Friar, 1987).

An apparent light quantity effect on pigmentation was the increase in the PBP/chl *a* ratio with decreasing light levels in the open control samples from 1987. Similar inceases have been documented in other red algae (Larkum & Barrett, 1983). Since phycobiliproteins are the primary light harvesting components for photosystem II in the Rhodophyta, an increase in the pigments at lower irradiance levels should theoretically increase light absorption (Gantt, 1990).

Photosynthesis versus irradiance curves for low and high light-acclimated field populations of *B. boryanum* indicated that in both light saturation was in the range of the 250 μmol m^{-2} s^{-1} irradiance value which Kremer (1983) determined for a European population of *Batrachospermum* sp. This relatively low light saturation value would favor growth under irradiances similar to those that were found at the shaded stream site in the winter and

early spring (range ca. 200-530 μmol m^{-2}s^{-1}), the period of peak biomass for *B. boryanum*.

Photosynthetic action spectra most closely resembled those of marine rhodophytes that have relatively high levels of phycocyanin, such as *Porphyra umbilicalis* (Lüning & Dring, 1985), but the protosynthetic response to wavelength of *B. boryanum* was somewhat broader. Maximum photosynthesis occurred within the absorbance range of the phycobiliprotein pigments, although it was not possible to statistically distinguish individual peaks. The decline in photosynthesis in the red region of the spectrum was not as pronounced as that reported by Lüning & Dring (1985) for various marine rhodophytes. In some green and brown seaweeds with thick thalli, action spectra between 430 and 680 nm are almost flat (Lüning & Dring, 1985). It is possible that a similar "flattening" occurred in *B. boryanum*, but to a lesser extent. The broad photosynthetic response to wavelengths in *B. boryanum* indicated a high degree of flexibility in utilizing light of different qualities. This was consistent with the lack of significant differences in photosynthesis among the various light quality groups in the laboratory study, but contrasted with work done on *Porphyridium purpureum* by Gantt (1990). In that alga red light (> 660 nm) grown cells had a lower rate of oxygen evolution that those grown under neutral filtering of equal irradiance.

The greater number of phycobilisomes per unit area in low light acclimated field population of *B. boryanum* as compared to high plants is in agreement with the findings of Staehelin *et al.* (1978) and Waaland *et al.* (1974) for marine rhodophytes. The greater phycobilisome size in shaded populations of *B. boryanum* is not substantiated by previous electron microscopic examinations of Rhodophyta (MacColl & Guard-Friar, 1987). In the Cyanophyta evidence has been presented supporting light quality effects on phycobilisome size (Raps *et al.*, 1985; Siegelman & Kycia, 1982).

As in the field study, most of the evidence from the laboratory did not support light quality acclimation of the photosynthetic apparatus in *B. boryanum*. Unlike in the field study, PC/PE ratios changed in response to light quantity. The lower PC/PE ratios that were observed under the highest acclimation irradiance were contrary to the results of Waaland *et al.* (1974) who found increases in this ratio under high light conditions in the marine rhodophyte *Griffithsia pacifica*. The observation that the PBP/chl *a* ratio had decreased under higher irradiances was in accord with that study and with *in situ* populations at the open site in this study. In some marine cyanophytes, phycoerythrin has been preferentially utilized as a nitrogen source under low conditions (MacColl & Guard-Friar, 1987). This could account for the higher PC/PE ratio that was observed in *B. boryanum* under low light conditions in this study. Declines in PBP/chl *a* under high light may be due in part to photooxidation of the phycobiliprotein pigments (MacColl & Guard-Friar, 1987).

The finding that most pigment changes in *B. boryanum* were related to total irradiance is consistent with the current concepts of photoacclimation in the Rhodophyta (Gantt, 1990; MacColl & Guard-Friar, 1987). However, possible phycobiliprotein utilization for metabolism could influence pigment

ratio changes under different light conditions. This phenomenon should be examined further in the freshwater environment.

ACKNOWLEDGEMENTS

We gratefully acknowledge the following individuals for their help in various aspects of this study: Dr. Harold Batchelder, Dr. Mattew Dring, Dr. Elizabeth Gantt, Dr. Julie Hambrook, Mr. Grant Jolly, Ms. Helen Kycia, Dr. Harold Siegelman, Dr. Elijah Swift and Mr. Jeffrey van Keuren. This research was funded by N.S.F. grant 8906989 and N.S.E.R.C. grant OGP105629 to R.G. Sheath and the Department of Botany, University of Rhode Island. Help in manuscript preparation by Christine Everson, Marion Jenkins and Livia Tyler is appreciated.

REFERENCES

BOGORAD L., 1975 - Phycobiliproteins and complementary chromatic adaptation. *Annu. Rev. Plant. Physiol.* 26: 369-401.

DRING M.J., 1981 - Chromatic adaptation of photosynthesis in benthic marine algae: An examination of its ecological significance using a theoretical model. *Limnol. Oceanogr.* 26: 271-284.

FEDERER C.A. & TANNER C.B., 1966 - Spectral distribution of light in the forest. *Ecology* 47: 55-560.

GANTT E., 1990 - Pigmentation and photoacclimation. *In* COLE K.M. & SHEATH R.G. (Eds.). *Biology of the red algae.* Cambridge Univ. Press, Cambridge. pp. 203-220.

HONSELL E., KOSOVEL V. & TALARICO L., 1984 - Phycobiliprotein distribution in the Rhodophyta: Studies and interpretations on the basis of their absorption spectra. *Bot. Mar.* 27: 1-16.

KREMER B.P., 1983 - Untersuchungen zur Ökophysiologie einiger Süsswasserrotalgen. *Dechiana (Bonn)* 136: 31-42.

LARKUM A.W.D. & BARRET J., 1983 - Light harvesting processes in algae. *In* WOOLHOUSE H.W. (Ed.). *Advances in Botanical Research.* Vol. 10. Academic, New York.

LEVY I. & GANTT E., 1988 - Light acclimation in *Porphyridium purpureum* (Rhodophyta): growth, photosynthesis, and phycobilisomes. *J. Phycol.* 24: 452-458.

LÜNING K. & DRING M.J., 1985 - Action spectra and spectral quantum yield of photosynthesis in marine macroalgae with thin and thick thalli. *Mar. Biol.* 87: 119-129.

MacCOLL R. & GUARD-FRIAR D., 1987 - *Phycobiliproteins.* CRC Press, Boca Raton, Florida.

RAMUS J., 1983 - A physiological test of the theory of complementary chromatic adaptation. II. Brown, green and red seaweeds. *J. Phycol.* 19: 173-178.

RAMUS J. & VAN DER MEER J.P., 1983 - A physiological test of the theory of complementary chromatic adaptation. I. Color mutants of a red seaweed. *J. Phycol.* 19: 86-91.

RAPS S., KYCIA J.H., LEDBETTOR M.C. & SIEGELMAN H.W., 1985 - Light intensity adaptation and phycobilisome composition of *Microcystis aeruginosa*. *Plant Physiol.* 79: 983-987.

RYAN T.A., JOINER B.L. & RYAN B.F., 1976 - *Minitab student handbook*. PWS Pub., Boston.

SHEATH R.G. & BURKHOLDER J.M., 1985 - Characteristics of softwater streams in Rhode Islands. II. Composition and seasonal dynamics of macroalgal communities. *Hydrobiologia* 128: 109-118.

SIEGELMAN H.W. & KYCIA J.H., 1978 - Algal biliproteins. *In* HELLEBUST J.A. & CRAIGIE J.S. (Eds.), *Handbook of phycological methods. Physiological and biochemical methods.* Cambridge University Press, Cambridge.

SIEGELMAN H.W. & KYCIA J.H., 1982 - Molecular morphology cyanobacterial phycobilisomes. *Plant Physiol.* 70: 887-897.

STAEHELIN L.A., GIDDINGS T.H., BADAMI P. & KRSYMOWSKI W.W., 1978 - A comparison of the supramolecular architecture of photosynthetic membranes of blue-green, red and green algae and of higher plants. *In* DEAMER D.W. (Ed.). *Light transducing membranes.* Academic, New York.

THIRB H.H. & BENSON-EVANS K., 1983 - Ultrastructure of freshwater alga *Lemanea* Bory, structure and development of the male and female organs. *Nova Hedw.* 38: 569-582.

TRISKA F.J., KENNEDY V.C., AVANZINO R.J. & REILLY B.N., 1983 - Effect of simulated canopy cover on regulation of nitrate uptake and primary production by natural periphyton assemblages. *In* FONTAINE T.D. III & BARTEL S.M. (Eds.) *Dynamics of lotic ecosystems.* Ann Arbor Science, Ann Arbor, Mich.

WAALAND J.R., WAALAND S.D. & BATES G., 1974 - Chloroplast structure and pigment composition in the red alga *Griffithsia pacifica:* Regulation by light intensity. *J. Phycol.* 10: 193-199.

OBSERVATIONS EN MICROSCOPIE À FLUORESCENCE DES NOYAUX DU *CLADOPHORA PYGMAEA* (CLADOPHORACÉES, SIPHONOCLADALES)

Sigurdur JÓNSSON* et Liliane CHESNOY**

* Laboratoire de Biologie Végétale Marine, Université P. et M. Curie, 7 Quai Saint-Bernard, 75230 Paris Cedex 05, France.
** Laboratoire des Membranes Biologiques, Université Paris VII, 2 Place Jussieu, 75251 Paris Cedex 05, France.

RÉSUMÉ - Le microscope à fluorescence révèle, après coloration à l'acridine orange, 9 à 32 petits noyaux par cellule végétative chez *Cladophora pygmaea* Reinke, récoltée dans les eaux danoises. La croissance est surtout intercalaire. Les divisions nucléaires sont synchrones à l'intérieur de chaque cellule et ne présentent pas un rapport direct avec la cytocinèse comme c'est la règle dans le genre *Cladophora*.

ABSTRACT - Entire thalli of *Cladophora pygmaea* from Danish waters (Kattegat) were fixed in 70° ethanol, washed in distilled water and stained in acridin orange solution at the concentration of 0,05 mg AO ml^{-1} in a phosphate buffer, 0,15 M at pH 6,7. They were observed in a Zeiss epifluorescence microscope equipped with suitable excitation / barrier filters: FI 500, excitation filter BG_3, barrier filters "47" and "65". Cells turn out to be multinucleate, each containing 9 to 32 small nuclei. Growth appears to be mainly intercalary. Nuclear divisions are simultaneous for each cell and are not immediately followed by cytokinesis as usually in the genus *Cladophora*.

MOTS CLÉS : Epifluorescence, nuclei, *Cladophora pygmaea*, Chlorophyta.

INTRODUCTION

Cladophora pygmaea se distingue de toutes les autres espèces de *Cladophora* connues par sa taille réduite. Elle ne dépasse guère 1 à 2 mm de hauteur. C'est une espèce marine qui pénètre dans les milieux saumâtres (S: 15‰ environ). Elle vit avec diverses Phéophycées et Rhodophycées, parfois encroûtantes, dans les fissues des rochers ou sur les petits galets, à des profondeurs variant de 2 à 35 m.

Cette espèce a été décrite d'après les échantillons récoltés dans la Baie de Kiel, dans la Mer Baltique (Reinke, 1988, 1989 a et b).

La répartition de *Cladophora pygmaea* semble assez large. Elle se cantonne dans les eaux froides tempérées. Elle a été trouvée sur les côtes

ouest de la Suède (Waern, 1940; Söderström, 1963), à l'intérieur du fjord d'Oslo (Sundene, 1953). Sur les côtes du Danemark, en Kattegat, elle a été identifiée il y a dix ans (Tyge Christensen, *in litteris*); une publication vient d'être consacrée à sa présence à la suite de nouvelles récoltes (Lundsteen, 1991 - Ministère de l'Environnement, Copenhague - *fide* Tyge Christensen). De plus, elle a été signalée sur les côtes de la Grande-Bretagne (Irvine *et al.*, 1977), de l'Irlande et de la France (Maggs & Guiry, 1981*). En Amérique du Nord on l'a récoltée en plusieurs endroits, sur les côtes atlantiques (Wilce, 1970; Hooper & South, 1977) et pacifiques (Norris & Hollenberg, 1969).

Si les études morphologiques de *C. pygmaea* sont bien documentées (Reinke, 1889 a et b; Waern, 1940; van den Hoek, 1963, 1982; Wilce, 1970), sa reproduction et sa structure cellulaire restent, par contre, insuffisamment connues. Dans la description générale du taxon américain l'état plurinucléé des cellules - chaque cellule contenant jusqu'à 20 noyaux ou plus - est indiqué, sans autres précisions (Wilce, 1970). La croissance intercalaire du thalle est aussi mentionnée, de même que la présence de zoïdes quadriflagellés. La présente note apporte quelques précisions quant à l'état plurinucléé des cellules et à la croissance intercalaire.

MATÉRIEL ET MÉTHODES

Le matériel a été récolté en juin 1991 sur la côte du Danemark, dans le Kattegat, sur un fond rocheux, appelé Store Middelgrund, à 12 m de profondeur, par S. Lundsteen. Isolé et identifié comme *Cladophora pygmaea* Reinke par R. Nielsen (Botanisk Museum, Université de Copenhague), il a été fixé à l'alcool 70° additionné d'un peu de glycérine, puis expédié à Paris.

La technique de coloration des noyaux par l'acridine orange (AO) est inspirée par la méthode de Couturier *et al.* (1973) pour la coloration des chromosomes humains. Après rinçage du matériel à l'eau distillée, les échantillons ont été montés directement entre lame et lamelle dans la solution de l'AO à la concentration finale de 0,05 mg $AO.ml^{-1}$, obtenues par mélange des solutions suivantes:

A. Solution-mère à la concentration de 1 mg $AO.ml^{-1}$ dans de l'eau bi-distillée .... 5 ml

B. Tampon phosphate de Sörensen, 0,15M, pH 6,7 .... 95 ml

L'observation a été faite en lumière ultraviolette proche du visible, au microscope à fluorescence de type "Zeiss Model II FI vertical illuminator", équipé d'une lampe à vapeur de mercure HBO 200 W/4 (Ozram) et avec la combinaison suivante: FI 500, filtre d'excitation II = BG3 et filtres d'arrêt de "47" et "65". Les noyaux fluorescent en vert brillant, le cytoplasme en rouge. Les microphotographies en noir et blanc ont été obtenues avec un

* La présence de *C. pygmaea* à Roscoff, signalée par ces auteurs, n'a pu être confirmée jusqu'ici.

film Kodak Tri-X pan 400, avec les objectifs Fl Neofluor 10/0,30 et Fl Neofluor 16/0,40**.

RÉSULTATS

La figure 1A montre, dans son intégralité, un sujet de *Cladophora pygmaea*, haut de 0,62 mm environ. Il est composé de 40 cellules, y compris la cellule basale, caractérisée par son épatement dû à l'épaississement de la paroi cellulaire. La cellule suprabasale porte un verticille de 4 rameaux, insérés obliquement ou horizontalement. Deux rameaux portent à leur base des ramules de second ordre, mais on n'observe pas un indice de ramification acropète. Les rameaux sont parfois rétrécis vers le haut, se terminant le plus souvent par une cellule légèrement conique. Le diamètre cellulaire varie de 17,3 μm à 57,3 μm. Les cellules, isodiamétriques ou deux fois plus longues que larges, sont pourvues d'une paroi cellulaire lamelleuse particulièrement épaisse au niveau des cellules inférieures du thalle.

Chaque cellule, sauf la cellule podale qui paraît optiquement vide, contient *plusieurs petits noyaux* (diamètre: 4 μm). Ils fluorescent brillamment dans le vert sous l'action de l'AO. Dans les petites cellules on compte 7 à 9 noyaux, alors que les plus grandes en contiennent jusqu'à 32. Ils sont uniformément répartis dans la cellule. Quelques cellules intercalaires plus allongées renferment des noyaux en anaphase ou télophase synchrones (fig. 1 B, flèches). Ces cellules ne montrent aucun indice de cloisonnement transversal ce qui souligne l'indépendance relative entre divisions nucléaires et cloisonnement cellulaire. Des divisions nucléaires s'observent aussi dans les cellules apicales.

DISCUSSION

Une des caractéristiques fondamentales définissant le genre *Cladophora* est l'état plurinucléé des cellules et l'indépendance relative de la division des noyaux et de la septation transversale (Jónsson, 1962). En raison de la taille réduite de *Cladophora pygmaea* on aurait pu croire que les cellules ne renfermaient qu'un nombre limité de noyaux, voire un seul comme chez le *Spongomorpha aeruginosa* (L.) van den Hoek, par exemple. Or, de ce point de vue, *Cladophora pygmaea* ne diffère en rien des autres espèces du genre *Cladophora*, comme par exemple le *Cladophora rupestris* (L.) Kütz. qui contient environ 20 noyaux somatiques par cellule (Jónsson & Chesnoy, 1971). Le taxon américain du *Cl. pygmae* semble, pour ce caractère, identique à celui du Danemark. De plus, les divisions synchrones des noyaux à l'intérieur de chaque cellule et l'absence de cytocinèse au moment des divisions nucléaires chez *Cladophora pygmaea* sont de nature à renforcer les liens de cette espèce avec le genre *Cladophora*.

** Cette méthode, très rapide, permet également de mettre en évidence les noyaux dans du matériel vivant ou conservé à l'eau de mer formolée à 5%, voire dans des échantillons d'herbier, même anciens.

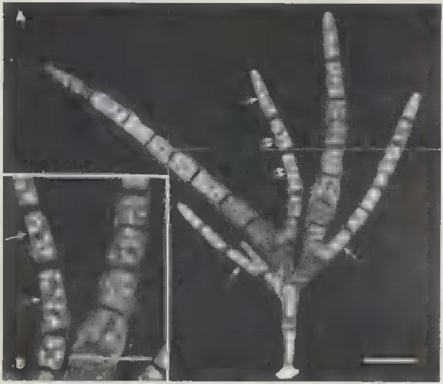


Fig. 1. - *Cladophora pygmaea:* observation en microscopie à fluorescence après coloration à l'acridine orange. A - thalle entier montrant l'état plurinucléé des cellules (sauf la cellule basale et une cellule lésée); de nombreuses cellules montrent des noyaux en mitose (flèches). B - détails de la région indiquée par des doubles flèches sur le cliché A; noter l'absence de cytocinèse et le synchronisme des divisions nucléaires à l'intérieur de chaque cellule. Echelle: 0,1 mm.

Les divisions nucléaires sont surtout observées dans les cellules intercalaires. La croissance de l'espèce semble donc être préférentiellement intercalaire comme plusieurs auteurs l'ont déjà suggéré, en se basant simplement sur les dimensions des cellules (par ex.: Waern, 1940; Wilce, 1970; van den Hoek, 1963, 1982).

Initialement, en raison de la taille des individus, le sous-genre *Chamaethamnion* a été créé pour recevoir le *Cladophora pygmaea* (Reinke, 1889 a). Cet auteur fut suivi par van den Hoek (1963, 1982) qui considère toutefois le sous-genre de Reinke comme une section du *Cladophora*. On peut s'interroger sur l'opportunité de maintenir un sous-genre ou une section pour une espèce dont le seul caractère distinctif serait la petite taille.

REMERCIEMENTS

Nous savons gré au Dr Ruth Nielsen et Steffen Lundsteen, Botanisk Museum, Université de Copenhague, de nous avoir fourni le matériel. Nous remercions également Pr. Tyge Christensen, Institut for Sporoplanter, Université de Copenhague, pour avoir encouragé la publication de ces résultats.

BIBLIOGRAPHIE

COUTURIER J., DUTRILLAUX B. & LEJEUNE J., 1973 - Etude de fluorescence spécifiques des bandes R et des bandes Q des chromosomes humains. *Compt. Rend. Hebd. Acad. Sci.*, sér. D 276: 339-342.

HOEK C. van den, 1963 - *Revision of the European species of Cladophora.* Leiden E.J. Bill, XI + 248p. + 55pl.

HOEK C. van den, 1982 - A taxonomic revision of species of *Cladophora* (Chlorophyceae) in the North Atlantic Ocean and their geographic distribution. *Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk.*, Reeks 2, 78: 1-236.

HOOPER R. & SOUTH G.R., 1977 - Additions to the benthic marine flora of Newfoundland III, with observations on species new to Eastern Canada and North America. *Naturaliste Canad.* 104: 383-394.

IRVINE D.E.G., GUIRY M.D., TITLEY I. & RUSSEL G., 1975 - New and interesting marine algae from the Shetland Isles. *Brit. Phycol. J.* 10: 57-71.

JÓNSSON S., 1962 - Recherches sur les Cladophoraceae marines (structure, cycles comparés, conséquences systématiques). *Ann. Sci. Nat. Bot.*, 12e sér., III: 25-230 + 16 pl.

JÓNSSON S. & CHESNOY L., 1971 - Méiose et sporogenèse chez le *Cladophora rupestris* (L.) Kütz. *C.R. Compt. Rend. Hebd. Acad. Sci.*, sér. D 272: 1754-1756.

LUNDSTEEN S., 1991 - *Rapport du Ministère de l'Environnement*, Copenhague.

MAGGS C.A. & GUIRY M.D., 1981 - Le *Cladophora pygmaea* Reinke, espèce nouvelle pour les côtes de France. *Trav. Stat. Biol. Roscoff*, n. s. 27: 11-13.

NORRIS R.E. & HOLLENBERG G.J., 1969 - Notes on marine algae of Washington and Southern British Columbia IV. *Syesis* 2: 115-119.

REINKE J., 1888 - Einige neue braune und grüne Algen der Kieler Bucht. *Ber. Deutsch. Bot. Ges.*, VI, 7: 1-2.

REINKE J., 1889a - Algenflora der Westlichen Ostsee. Deutschen Anteils. *Ber. Komm. wiss. Untersuch. d. deutscher Meere.* Kiel. XI + 85 p.

REINKE J., 1889 b - Atlas deutscher Meeresalgen. *Ber. Komm. wiss. Untersuch. d. deutscher Meere.* Heft I, Tafel 1 bis 25.

SÖDERSTRÖM J., 1963 - Studies in *Cladophora*. *Bot. Gothob.* 1: 5-147.

SUNDENE O., 1953 - The algal vegetation of Oslofjord. *Skr. Norsk. Vidensk.-Akad.* Oslo, *Mat.-Naturwidensk. Kl.* N° 2: 1-244 + carte.

WAERN M., 1940 - *Cladophora pygmaea* und *Leptonema lucifugum* an der schwedischen Westküste. *Acta Phytogeogr. Suecica* 13: 1-6.

WILCE R.T., 1970 - *Cladophora pygmaea* Reinke in North America. *J. Phycol.* 6: 260-263.

STROMBOMONAS (EUGLENOPHYTA) NUEVAS O RARAS DE LA ARGENTINA.

Yolanda ZALOCAR de DOMITROVIC

Centro de Ecología Aplicada del Litoral (CONICET)
C.C. 291, 3400 Corrientes, Argentina.

RESUMEN - En este trabajo presentamos algunos taxa de *Strombomonas* Defl. provenientes de la región subtropical de la Argentina. Se describen diez taxa de los cuales cinco son nuevos para la ciencia: tres especies *S. confortii*, *S. pizarroi* y *S. tellii* y dos variedades *S. tambowika* (Swir.) Defl. var. *magnifica* y *S. tambowika* var. *rhomboidea*.

RÉSUMÉ - Ce travail est consacré aux *Strombomonas* Defl. de la région subtropicale de l'Argentine. Dix taxa comprenant espèces, variétés et formes, sont présentés. Parmi ceux-ci, trois nouvelles espèces *Strombomonas confortii*, *S. pizarroi* et *S. tellii*, et deux nouvelles variétés *S. tambowika* (Swir.) Defl. var. *magnifica* et *S. tambowika* var. *rhomboidea* sont proposées.

ABSTRACT - This paper deals with taxa of *Strombomonas* Defl. from subtropical Argentina. Ten taxa are described, of which five are new for science: three species *S. confortii*, *S. pizarroi* and *S. tellii*, and two varieties *S. tambowika* (Swir.) Defl. var. *magnifica* and *S. tambowika* var. *rhomboidea*.

PALABRAS CLAVES: Taxonomia, Euglenophyta, *Strombomonas*, Argentina.

KEY WORDS : Taxonomy, Euglenophyta, *Strombomonas*, Argentine.

INTRODUCCION

Los ambientes acuáticos permanentes y semipermanentes ubicados sobre la margen derecha del eje potámico Paraguay-Paraná (Argentina) albergan una rica y variada ficoflora de Euglenophyta. Este grupo, la mayor parte del año, suele encontrarse asociado a otras algas flageladas, principalmente Cryptophyceae y Chlorophyceae del orden Volvocales. En algunas ocasiones, particularmente en época de aguas bajas o de prolongada sequía, suelen alcanzar la dominancia casi absoluta del fitoplancton.

En un trabajo anterior (Tell & Zalocar de Domitrovic, 1985) presentamos los resultados obtenidos sobre un estudio florístico de los euglenofitos pigmentados de la provincia del Chaco. En muestreos posteriores, como parte de un proyecto más amplio sobre la caracterización limnológica de es-

los cuerpos de agua (Bonetto *et al.*, 1984; Zalocar de Domitrovic *et al.*, 1986; y publicaciones en preparación), encontramos taxones nuevos y otros descriptos anteriormente, que resultan interesantes por su escasa frecuencia en la naturaleza.

El objectivo de este trabajo es contribuir al conocimiento de los Euglenofitos pigmentados de la zona subtropical de Argentina. Se describen e ilustran diez taxones de *Strombomonas* Defl. de los cuales se proponen tres especies y dos variedades nuevas para la ciencia. De los cinco taxones restantes se presenta información adicional sobre la morfología, dimensiones celulares y distribución geográfica.

MATERIAL Y METODOS

Los taxa de *Strombomonas* discutidos en éste trabajo proceden de ambientes leníticos de la provincia del Chaco y de islas del rio Paraná, la mayoría de ellos de escasa profundidad y con vegetación marginal de macrófitos. El material fué colectado superficialmente cerca de la costa y en aguas libres de vegetación, con una red de planeton de 25 μm de apertura de malla. Parte de este material fué estudiado vivo y otra parte fué fijado con formaldehido al 4% y depositado en la Colección del Laboratorio de Ficologia del Centro de Ecología Aplicada del Litoral (CONICET).

Las localidades de muestreo (señeladas en el mapa) son las siguientes:

- Madrejón El Puente: sobre la margen derecha del valle de inundación del rio Paraná, vegetado por *Eichhornia crassipes* (Mart.) Solms-Laub. Conductividad 140 μS.cm^{-1}, pH 7,4 (30/03/79)[1].

- Laguna Turbia: en isla del rio Paraná (I. del Cerrito), aguas de escasa transparencia y sin vegetación acuática. Conductividad 180 μS.cm^{-1}, pH 7,4 (0.2/03/79).

- Laguna Catay: en isla del río Paraná (I. Pelón), en contacto casi permanente con el rio, vegetada por *Polygonum* L. Contuctividad 76 μS.cm^{-1}, pH 7,1 (02/03/79).

- Bañado Chouí: en isla del rio Paraná (I. Chouí), densamente vegetado por *Paspalum* L. Contuctividad 64 μS.cm^{-1}, pH 6.0 (06/05/82).

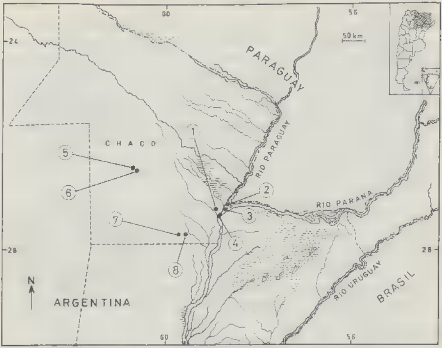
- Laguna A, en P. R. S. Peña: aguas de escasa transparencia, densamente vegetada por *Lemna* L., pH 6,0 (23/12/89).

- Laguna B, en P. R. S. Peña: aguas de escasa tranparencia, sin vegetación marginal, con frecuentes floraciones de *Euglena sanguinea* Ehr., pH 6,0 (24/09/90).

- Estero Cocherek: aguas turbias, con elevado contenido de materia orgánica y material en suspensión, vegetado por *Thalia multiflora* Hork. y *Ludwigia* L. Conductividad 290 μS.cm, pH 7,1 (09/05/79).

---

[1] La conductividad eléctrica (con Conductimetro YSI, 33 SCT) y el pH (con Comparador Lovibond 1000) fueron medidos paralelamente a los muestreos.



Mapa - Ubicación geográfica de los ambientes estudiados. 1: madrejón El Puente, 2: laguna Turbia, 3: laguna Catay, 4: bañado Chouí, 5: laguna A, P. R. S. Peña, 6: laguna B, P. R. S. Peña, 7: estero Cocherek, 8: estero Felman.

- Estero Felman: con características semejantes al anterior. Contuctividad 290 μS.cm^{-1}, pH 7,1 (15/11/78).

El estudio de los taxones específicos e infraespecíficos se basó fundamentalmente en las obras de Deflandre (1930), Balech (1944), Huber-Pestalozzi (1955) y Tell & Conforti (1986).

DESCRIPCION TAXONOMICA Y DISCUSION

Strombomonas confortii **nov. sp.**

Loricae conicae cum basale parte lata quam apicale. Basis expansionem similem alae habet, quae totam capsulam circundat. Collum brevem rectum, aut leviter inclinatum sectionis obliquae atque contorni irregularis. Appendix caudalis plane distincta et obliqua. Capsula parietis crassae irregularis, glandacea particulis mediis depositis. In transversale sectione optica loricae circulares sunt. Chloroplasti parietales et disciformes. Copiosis granulis paramyli. Long. 47-48 µm, lat. 38-38,5 µm, long. appendicis caudalis: 12 µm colli long. 5 µm et lat. 7-9 µm.

Iconotypus: figura nostra, fig. 1 a-d.

Lórigas cónicas, la parte basal es más ancha que la apical, con forma de un frasco Erlenmeyer. La base presenta una característica expansión en forma de ala que rodea toda la cápsula. El cuello es corto, recto o ligeramente inclinado, de sección oblicua y borde irregular. Apéndice caudal bien diferenciado y oblicuo. Cápsula de pared gruesa, irregular, de color marrón amarillento y con deposición de partículas del medio. En corte óptico transversal las lórigas son circulares. Cloroplastos parietales y discoides. Gránulos de paramilon elipsoides y abundantes. Estigma de tamaño mediano y elongado. Flagelo de longitud igual o menor que la lóriga. Long. 47-48 µm, diámetro 38-38,5 µm, long. apéndice caudal 12 µm, cuello: 5 µm de long. y 7-9 µm de diámetro. Material estudiado: Laguna A, en P.R.S. Peña (Muestra C-3507).

Esta nueva especie pertenece a la sección *Rotundatae*, subsección *Corrugatae*. Unicamente por poseer el cuerpo de la lóriga la forma de un frasco Erlenmeyer, se asemeja ligeramente a *Strombomonas ensifera* (Daday) Defl. var. *javanica* Huber-Pest. La presencia de una expansión alar transversal rodeando la base de la lóriga es el carácter principal que la diferencia de todas las demás *Strombomonas*. Hay otras especies con expansiones alares, pero están dispuestas longitudinalmente y en espiral en número de 2 y de 4 en *S. diptera* Zaloc. *et* Tell y *S. tetraptera* Balech *et* Dast., respectivamente.

***Strombomonas pizarroi* nov. sp.**

Capsula huius speciei duas undas notabiles habet, basalem major quam apicalem. Contorni ambarum undarum ample rotundati sunt. Collum breve sectionis obliquae cum undis irregularibus. Appendix caudalis recta aut leve torta, ostendere potest aut non similis collo, membranam transversalem hyalinam in sua base. Paries levis, fusca, aliquando cum particulis mediis glomeratis. In optica sectione transversa loricae orbiculares sunt. Long. 50-69 µm lat. max. 27-31 µm lat. min. 17-19,5 µm long. appendicis caudalis 15-21 µm colli 5-5,5 µm long et 7 µm lat.

Iconotypus: figura nostra, fig. 2 a-b.

La cápsula de esta especie se caracteriza por presentar dos notables abultamientos, el basal de mayor magnitud que el apical. Ambos son de contornos ampliamente redondeados. El cuello es corto, de sección oblicua y con ondulaciones irregulares. El apéndice caudal es recto o ligeramente torcido y puede presentar o no, al igual que el cuello, une membrana transversal hialina en su base. La pared es lisa, de color pardo amarillenta y, ocasionalmente, con partículas aglutinadas del medio. En corte óptico transversal las lórigas son circulares. Cloroplastos parietales y discoides. Gránulos de paramilon elipsoides y abundantes. Estigma grande y elongado. Flagelo de longitud menor o igual que la lóriga. Long. 50-69 µm, diámetro máximo 27-31 µm, diámetro mínimo 17-19,5 µm, long. apéndice caudal 15-21 µm, cuello: 5-5,5 µm de long. y 7 µm de diámetro. Material estudiado: Lagunas A y B, en P. R. S. Peña (Muestras C-3507 y C-3561).

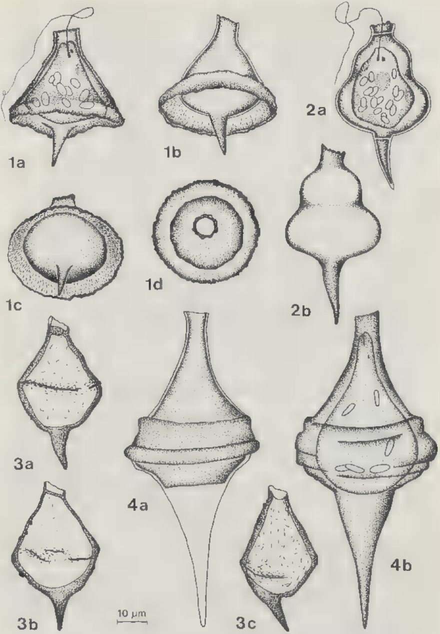


Fig. 1: *Strombomonas confortii*; a-b: aspecto general; c: vista caudal; d: vista apical. Fig. 2 a-b: *S. pizarroi*. Fig. 3: *S. tellii*; a-b: aspecto general; c: vista lateral. Fig. 4 a-b: *S. ensifera*.

Ubicamos esta nueva especie en la sección *Rotundatae*, subsección *Erugatae*, serie *Caudatae*. Por la ondulación de los lados en vista frontal podemos relacionarla con *Strombomonas gigardiana* (Playf.) Defl. pero en ésta las lórigas son hexagonales o cilíndricas con los lados casi paralelos y con paredes de aspecto generalmente rugoso. También podemos relacionarla con *S. ensifera* (Daday) Defl. var *javanica* Huber-Pest. sólo por presentar la base de la lóriga más ancha, de paredes lisas y la base del apéndice caudal con una membrana transversal hialina. Nuestra nueva especie se diferencia en la forma ligeramente trapezoidal donde se destacan dos abultamientos u ondulaciones, ambos bien diferenciados por una marcada concavidad.

***Strombomonas tellii* nov. sp. (fig. 3 a-c)**

Loricae rhomboidales cum aequatoriale plica. Collum breve transversum margine inaequale. Appendix caudalis turbinata et recta in frontale aspectu, recta et symmetrica aut obliqua et asymmetrica in laterali aspectu; in sectione transversa, elliptica est. Paries loricae crassa, glandacea. Long. capsulae 49,5-51 µm diam. max. 29 µm in laterali aspectu 25,5 µm long, appendicis caudalis 10 µm colli: long. 2-3 µm et lat. 6,6-7 µm.

Iconotypus: figura nostra, fig. 3 a-c.

Lórigas romboidales con un pliegue ecuatorial. Cuello corto, oblicuo y de borde irregular. El apéndice caudal es cónico y recto en vista frontal. En vista lateral es recto y simétrico u oblicuo y asimétrico continuándose con uno de los lados de la cápsula. En corte óptico transversal es ampliamente elíptica. Pared celular gruesa, de color marrón amarillenta. Long. de la lóriga 49,5-51 µm, diámetro máximo 29 µm, en vista lateral 25.5 µm, long. del apéndice caudal 10 µm, cuello: 2-3 µm de long. y 6,5-7 µm de diámetro. Material estudiado: Laguna A. en P. R. S. Peña (Muestra C-3507).

Por la forma romboidal de las lórigas es afín a *Strombomonas gibberosa* (Playf.) Defl. y dentro de ésta a la var. *grisoli* Defl. por presentar un pliegue escuatorial. Pero se diferencia de ellas en las dimensiones celulares, el notable espesor de la pared, la ausencia de una membrana transversal hialina en la base del apéndice caudal y además, son elípticas en corte óptico transversal. Por este último carácter ubicamos esta nueva especie en la sección *Complanatae*.

***Strombomonas tambowika* (Swir.) Defl. var. *magnifica* nov. var. (fig. 5)**

A typo differt quia plicas perfecte transversas ad axem capsulae longitudinalem ostendet. Capsulae forma ellipsoidea est et paulatim acuminata ad extremum posterius usque in appendice caudale finire. Collum breve sectionis obliquae et contornus leviter irregularis. In sectione optica transversa, loricae orbiculares sunt. Capsulae long. 57-70 µm, lat. 24-48 µm, colli long. 3-4 µm et lat. 8-9 µm.

Iconotypus: figura nostra, fig. 5.

Esta variedad se diferencia del tipo por presentar plegamientos regulares, casi perfectamente transversales con respecto al eje longitudinal y mayor de la cápsula. La forma de la misma es ampliamente elipsoidal

aguzándose progresivamente hacia el apéndice caudal. El cuello es corto, de sección oblicua y borde ligeramente irregular. En corte óptico transversal las lórigas son circulares. Long. 57-70 μm, diámetro 24-48 μm, cuello: 3-4 μm de long. y 8-9 μm de diametro. Material estudiado: laguna Catay (Muestra C-1003), laguna Turbia (Muestra C-1006) y bañado Choui (Muestra C-2116).

Para esta especie se conocía sólo la variedad tipo mencionada para Rusia, Dinamarca, Bélgica, Java y Argentina (Buenos Aires).

***Strombomonas tambowika* (Swir.) Defl. var. *rhomboidea* nov. var. (fig. 6 a-b)**

A typo differt quia paries ornata est cum plicis transversis convergentibus in media parte capsulae. In sectione optica, illae plicae leve rhomboideae sunt. Capsulae long. 50 μm, lat. 22,5 μm, colli long. 2-3 μm et lat. 7,5 μm.

Iconotypus: figura nostra, fig. 6 a-b.

Esta variedad se diferencia del tipo por la ornementación de la pared en forma de pliegues transversales que convergen regularmente en la parte media de la cápsula. En corte óptico transversal son ligeramente romboidales. Long. 50 μm, diámetro 22,5 μm, cuello: 2-3 μm de long y 7,5 μm de diámetro. Material estudiado: Estero Cocherek (Muestra C-1092) y laguna B. en P. R. S. Peña (Muestra C-3561).

Sería interesante la observación de las variedades *magnifica* y *rhomboidea* en microscopio electrónico de barrido. Esto comprobaría si se trata realmente de pliegues o de aglutinación de partículas en las cápsulas ya que, como fuera señalado por Tell & Conforti (1984) las especies de *Strombomonas* aglutinan partículas del medio en sus lórigas.

***Strombomonas ensifera* (Daday) Defl. var. *ensifera* (fig. 4 a-b)**

Nuestros ejemplares responden a la descripción dada para el tipo (Deflandre, 1930) pero se diferencian de éste por presentar lórigas con la parte media más abultada, definida por bordes angulosos o redondeados, debido a la presencia de pliegues horizontales distribuidos regular o irregularmente. Además, la longitud de la lóriga es de menores dimensiones. Long. 104 μm, diámetro 44,5-60 μm, long. del apéndice caudal 46 μm, cuello: 20 μm de long. y 7-8,5 μm de diámetro. Material estudiado: Madrejón El Puente (Muestra C-2958), laguna Turbia (Muestra C-1006).

El delgado espesor de la pared, sumado a la intensa metabolia celular observada, podrían explicar quizás, en parte, la formación de tales plegamientos en las cápsulas de los organismos vivos. Posteriormente a la fijación (con formaldehido al 4%) la mayoría de los ejemplares presentaban prolongaciones espinosas irregulares en la abertura del cuello, interpretándose como los restos de la membrana embudiforme, característica de esta especie. Aparentemente la observación de tales prolongaciones es lo que motivó a Tafall (1943) a crear una nueva especie: *Trachelomonas beltrani*, quien la diferencia de *Strombomonas ensifera* (Daday) Defl. "por la corona espinosa que bordea el orificio flagelar y sus dimensiones considerablemente mayores". Las dimensiones celulares dadas por éste autor están comprendidas dentro del rango de variación de las dadas para *S. ensifera* y,

la corona espinosa a la que se refiere serían los restos de la membrana embudiforme. Por estas razones consideramos a *Trachelomonas beltrani* Taf. como especie sinónima de *Strombomonas ensifera* (Daday) Defl. confirmando lo sugerido por García de Emiliani (1977) quien no pudo observar el material vivo como para sinonimizar con certeza la forma descripta por Tafall (*op. cit.*).

Distribución geográfica: en zona tropical y subtropical del continente americano: Paraguay, México, Venezuela, Brazil, Surinam y Argentina.

***Strombomonas girardiana* (Playf.) Defl. var. *girardiana* fo. (fig. 7)**

Nuestros ejemplares se diferencian del tipo por presentar el apéndice caudal torcido formado un ángulo de 45° con respecto al eje longitudinal mayor de la lóriga. Longitud total 39.5 μm, diámetro 22,5 μm, long. apéndice caudal 10 μm, cuello: 4,5 μm de long. y 6 μm de diámetro. Material estudiado: Laguna B, en P. R. S. Peña (Muestra C-3561), bañado Chouí (Muestra C-2116) y estero Cocherek (Muestra C-1092).

En nuestro país se conocen dos variedades de esta especie, la var. *girardiana* (Corrientes, Chaco y Santa Fé) y la var. *triondulata* Tell et Zaloc. (Chaco). Esta última se conoce sólo para Argentina, mientras que la primera fué señalada además, para Australia, Egipto y Venezuela.

***Strombomonas scabra* (Playf.) Tell et Conf. var. *hiperintermedia* Conf. (fig. 8 a-d)**

Semejante a la variedad *intermedia* (Yacub.) Tell et Conf., pero se diferencia de ésta por sus mayores dimensiones celulares y mayor longitud del apéndice caudal. La base del cuello posee un marcado engrosamiento fuertemente coloreado, de mayor intensidad que el resto de la lóriga, la cual es marrón amarillenta. El apéndice caudal generalmente persenta material aglutinado sobre el mucílago. Long. de la lóriga 46,5-51 μm, diámetro 19,5-23 μm, cuello: 9,5-12 μm de long. y 4-4,5 μm de diámetro. Long. apéndice caudal 5,5-9 μm. Material estudiado: laguna B, en P. R. S. Peña (Muestra C-3561) y estero Cocherek (Muestra C-1092).

Los límites métricos de nuestros ejemplares son ligeramente inferiores a la variedad descripta originalmente por Conforti (1989: 74, fig. 14 a-c) y al M.E.B. por Tell & Conforti (1988: 545, Pl. V, fig. 1-4) para Buenos Aires.

Distribución geográfia: Argentina. Con este hallazgo en la provincia del Chaco ampliamos su distribución en la Argentina, donde se la conocía sólo para Buenos Aires.

***Strombomonas scabra* (Playf.) Tell et Conf. var. *ovata* (Playf.) Tell et Conf. fo. *caudata* (Tell et Zaloc.) Tell et Conf. (fig. 9 a-b)**

Esta forma se diferencia de la variedad tipo por presentar la base de la lóriga prolongada en un corto apéndice caudal y el cuello de mayor longitud. Al igual que lo señalado para la especie anterior, también aquí presentan un engrosamiento en la base del cuello y material inorgánico depositado sobre el mucílago de la parte basal de la cápsula. Long. 36-41 μm, diámetro

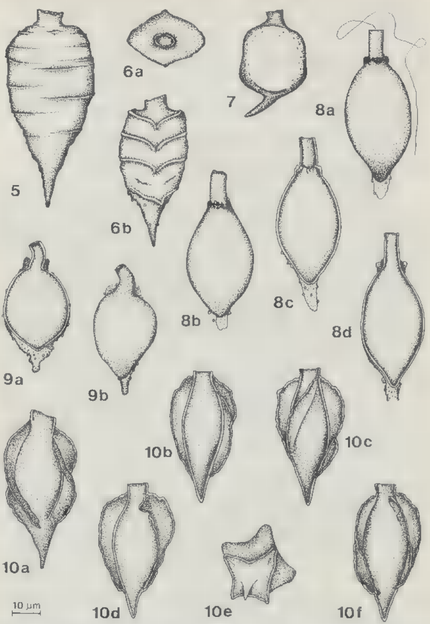


Fig. 5: *Strombomonas tambowika* var. *magnifica*. Fig. 6: *S. tambowika* var. *rhomboidea*; a: vista apical; b: aspecto general. Fig. 7: *S. girardiana* var. *girardiana* fo. Fig. 8 a-d: *S. scabra* var. *hiperintermedia*. Fig. 9 a-b: *S. scabra* var. *ovata* fo. *caudata*. Fig. 10: *S. tetraptera*; a, b, c, d, f: aspecto general; e: vista caudal.

21 µm, cuello: 8-10 µm de long. y 2-31 µm de diámetro. Material estudiado: Laguna B. en P.R.S. Peña (Muestra C-3561) y estero Cocherek (Muestra C-1092).

Las dimensiones celulares se aproximan a los límites métricos dados en la diagnosis original (Tell & Zalocar de Domitrovic, 1985: long. 35 µm, diámetro 22 µm, cuello: 4-5 µm de long. y 3 µm de diámetro) con la diferencia que en nuestros iconos el cuello es 3 a 5 µm más largo. Material estudiado: Laguna B, en P. R. S. Peña (Muestra C-3561) y estero Cocherek (Muestra C-1092).

Distribución geográfica: Argentina (provincia del Chaco).

***Strombomonas tetraptera* Balech et Dast. (fig. 10 a-f)**

Lórigas fusiformes que terminan en la parte anterior en un cuello corto y en la posterior en un apéndice caudal cónico. La lóriga está ornamentada con 4 expansiones alares longitudinales, ligeramente espiraladas. Pared celular hialina. El borde de las expansiones alares es de aspecto rugoso. En corte óptico transversal son cuadrangulares con los lados fuertemente cóncavos. Long. 46-47 µm, diámetro máximo 25-26 µm, long. apéndice caudal 8-9 µm, cuello: 2-3 µm de long. y 6,5-8 µm de diámetro. Material estudiado: Estero Felman (Muestra C-855) y laguna B, en P. R. S. Peña (Muestra C-3561).

Esta especie fué descripta para la provincia de Buenos Aires por Balech (1944) y posteriormente encontrada y redescripta al M.E.B. por Tell & Conforti (1988). Las dimensiones de la lóriga de nuestros ejemplares coinciden con las de la diagnosis original de Balech (*op. cit.*) y difieren ligeramente de las de Tell & Conforti (*op. cit.*) en la longitud del apéndice caudal (4 a 5 µm más largo) y en el diámetro del cuello (3,5 a 4 µm más angosto).

Distribución geográfica: Argentina. Con el hallazgo de nuestros ejemplares en dos ambientes acuáticos de la provincia del Chaco, distantes entre si unos 150km, ampliamos su distribución geográfica en nuestro país, donde hasta ahora, era conocida sólo para Buenos Aires.

AGRADECIMIENTOS

A los doctores G. Tell y V. Conforti la confirmación de los nuevos taxones y la lectura crítica del manuscrito. A la Prof. M.L. Acuña de la Cátedra de Lengua y Literatura Latina de la Facultad de Humanidades (Resistencia, Chaco), por la traducción de las diagnosis latinas.

BIBLIOGRAFIA

BALECH E., 1944 - *Trachelomonas* de la Argentina. *Anales Mus. Argent. Ci. Nat. "Bernardino Rivadavia"* 41: 221-322.

BONETTO C.A., ZALOCAR de DOMITROVIC Y. & LANCELLE H.G., 1984 - A limnological study of an oxbow-lake covered by *Eichhornia crassipes* in the Paraná river. *Verh. Internat. Verein. Limnol.* 22: 1315-1318.

CONFORTI V., 1989 - Algunos Euglenoideos nuevos o interesantes de la Argentina. *Cryptogamie, Algol.* 10 (1): 69-79.

DEFLANDRE O., 1930 - *Strombomonas*, nouveau genre d'Euglenacées (ex *Trachelomonas* Ehr. pro parte). *Arch. Protistenk* 69: 551-614.

GARCIA de EMILIANI M.O., 1977 - Nuevas especies de *Strombomonas* Defl. (Euglenophyceae) para la Argentina. *Physis B, (Buenos Aires)* 37 (93): 111-116.

HUBER-PESTALOZZI G., 1955 - *Das Phytoplankton des Susswasser, Euglenophyceen. In* THIENEMANN A., *Die Binnengewasser* 16 (4): 1-606.

TAFALL O., 1943 - Estudios sobre el plancton de Mexico. II. El género *Trachelomonas* Ehr., con descripción de nuevas especies. *Rev. Hisp. Amer. Ci. Puras y Apl.* 3 (8-9): 249-254.

TELL G. & CONFORTI V., 1984 - Ultraestructura de la lóriga de cuatro especies de *Strombomonas* Defl. (Euglenophyta) en M.E.B. *Nova Hedwigia* 40: 123-131.

TELL G. & CONFORTI V., 1986 - *Euglenophyta pigmentadas de la Argentina. Bibliotheca Phycologica* 75, Berlin - Stuttgart, 301 p.

TELL G. & CONFORTI V., 1988 - Quelques *Strombomonas* Defl. (Euglenophyta) de l'Argentine au microscope photonique et électronique à balayage. *Nova Hedwigia* 46 (3-4): 541-556.

TELL G. & ZALOCAR de DOMITROVIC Y., 1985 - Euglenophyta pigmentadas de la provincia del Chaco (Argentina). *Nova Hedwigia* 41: 353-391.

ZALOCAR de DIMITROVIC Y., VALLEJOS E.R. & PIZARRO H.N., 1986 - Aspectos ecológicos de la ficoflora de ambientes acuáticos del Chaco Oriental (Argentina). *Ambiente Subtrop.* 1: 92-111.

Cryptogamie, Algol. 1991, 12 (4): 283-287

THE IDENTITY OF *ARACHNOPHYLLUM DELILEI* MONTAGNE

Michael J. WYNNE

Department of Biology, University of Michigan,
Ann Arbor, MI 48109, USA.

ABSTRACT - The holotype in PC of *Arachnophyllum delilei* Montagne [= *Bangia delilei* (Montagne) Zanardini] from the Red Sea is identified as *Percursaria percusa* (C. Agardh) Bory. Therefore, this binomial is relegated to taxonomic synonymy within the latter taxon.

RÉSUMÉ - L'holotype (in PC) de *Arachnophyllum delilei* Montagne [= *Bangia delilei* (Montagne) Zanardini] de la Mer Rouge est à rapporter au *Percursaria percusa* (C. Agardh) Bory. Par conséquent ce binôme est relégué à une synonymie taxinomique du dernier taxon.

KEY WORDS : *Arachnophyllum delilei, Bangia delilei, Percursaria percusa,* Red Sea.

INTRODUCTION

Arachnophyllum delilei was described by Montagne (1857) on the basis of a Delile collection from the Red Sea. *Arachnophyllum* Zanardini (1843), the genus of Delesseriaceae (Rhodophyta) to which it was assigned, is rather poorly known, its generitype, *A. confervaceum* (Meneghini) Zanardini, being restricted to the Mediterranean Sea (Hauck, 1883-1885; Funk, 1955). Zanardini (1858) transferred *A. delilei* to a very different rhodophytan genus, *Bangia*, where it still remained in Papenfuss' (1968) Catalogue of Red Sea marine algae. Papenfuss stated that the systematic position and status of this taxon were "uncertain". De Toni (1900), who had retained the taxon in *Arachnophyllum*, also characterized it as a "Species inquirendae". An examination of type material of *Arachnophyllum delilei* in PC has permitted the resolution of the questionable status of this alga.

OBSERVATIONS

The single herbarium sheet in PC comprising the type collection of *Arachnophyllum delilei* has a total of five packets of various sizes. Several labels written in the hand of Montagne provide the pertinent data authenticating it as the type collection: "Arachnophyllum Delilei Mont.", "8e Centurie",

Fig. 1 - *Arachnophyllum delilei* Montagne [= *Percursaria percusa*]. Camera-lucida drawings of filaments in type collection (PC).

"in mari rubro", "M. Delile no. 2", and the date "1844". The names "Polycladia Commersonii Montg." and "Amphiroa fragilissima Lamx." correspond to two of the three hosts referred to by Montagne. In the packets are a few mounts of the host algae covered with a dense covering of filamentous algae. Montagne's account mentioned his new species enveloped the host algae with a thick tomentum. In the packets there is also a total of 14 mica mounts with additional tufts of *Arachnophyllum*. Hosts and epiphyte(s) are

all bleached and colorless, as was their condition when Montagne first described this alga. The filaments, when examined under the microscope, were seen to be mostly simple, biseriate filaments, usually 16-19 μm wide, occasionally and sporadically uniseriate (11-12 μm wide). Branching was not observed, nor were any reproductive structures. Rhizoidal cells were not present. Staining with aniline blue and with IKI revealed a single platelike chloroplast in each cell. The state of preservation of the material does not permit one to detect with certainty the presence of pyrenoids. These observations are in full agreement with the protologue.

The biseriate simple filaments of this material allow it to be identified as the green alga *Percursaria percusa* (C. Agardh) Bory. Morphological and life histories of this alga have been reported by Kornmann (1956) and Bliding (1963). The absence of rhizoids is compatible with Bliding's (1968) characterization of the monotypic family Percursariaceae as having no rhizoidal cells. Zanardini's (1858) transfer of this taxon to *Bangia* is incorrect in that a rhizoidal basal system is present in the Bangiales (Garbary *et al.*, 1980).

DISCUSSION

In Montagne's (1857) description of *Arachnophyllum delilei* he admitted that he had substantial difficulties in assigning this alga to a group, not certain whether it should be assigned to the Confervas (filamentous green alga) or the Florideae (red algae). He indicated that he re-examined it several times. It is important to point out that he did not detect any reproductive structures, saying that "l'absence de fructification... est fort à regretter".

Montagne was persuaded by some resemblance of his alga to Zanardini's *Arachnophyllum confervaceum* from the Adriatic Sea to assign the Red Sea alga of the same genus. Vegetative cells of *Arachnophyllum confervaceum* have been shown by Funk (1955) to contain many very small rhodoplasts arranged in bead-like chains, typical for most members of the Delesseriaceae. The single platelike chloroplast present in *Arachnophyllum delilei* is in agreement with the cytology of *Percursaria percusa* (Bliding, 1963).

Kützing (1866) received material of this alga from Montagne and, apparently unaware that Montagne had already described the alga, also provided a description, crediting the entry as "Arachnophyllum Delilei *(Montagne in litt.)*". Kützing depicted the alga as comprised of simple biseriate filaments with "sporis (?) simplicibus globosis lateralibus sessilibus (raris)". Such external spores or sporangia are foreign to *Percursaria*. Rather, there is a simple conversion of vegetative cells into zoospores or gametes, which are released without any dramatic alteration to the cell. It is concluded that the "sporis (?)" referred to by Kützing should be disregarded.

The distribution of *P. percusa* is now recognized to be cosmopolitan: both sides of the North Atlantic (South & Titley, 1986; Wynne, 1986), the Pacific coast of North America from British Columbia to central California (Abbott & Hollenberg, 1976; Scagel *et al.*, 1989), Japan (Yoshida *et al.*, 1990) and the Soviet Union (Zinova, 1967; Vinogradova, 1979), South Africa (Seagrief, 1984) and Australia (Womersley, 1984). De Toni (1889, as *Entero-*

morpha percusa) compiled a lengthy list of taxonomic and nomenclatural synonyms for *Percursaria percusa*. Papenfuss (1960) summarized the evidence for the recognition of *Percursaria* as distinct from *Enteromorpha*. The fact that Kützing (1850-1852) depicted the alga under four different names (*Schizogonium percursum*, *S. nodosum*, *S. pallidum*, and *S. virescens*) on the same plate reflects the past confusion regarding this alga.

ACKNOWLEDGEMENTS

I thank Dr. Françoise Ardré, PC, for the loan of the material.

BIBLIOGRAPHY

ABBOTT I.A. & HOLLENBERG G.J., 1976 - *Marine Algae of California*. Stanford Univ. Press, Stanford, California. xii + 827p.

BLIDING C., 1963 - A critical survey of European taxa in Ulvales Part I *Capsosiphon, Percursaria, Blidingia, Enteromorpha*. *Opera Botanica* 8(3): 1-160.

BLIDING C., 1968 - A critical survey of European taxa in Ulvales, II. *Ulva, Ulvaria, Monostroma, Kornmannia*. *Bot. Notiser* 121: 535-629.

De TONI G.B., 1899 - *Sylloge algarum*. Vol. I. Chlorophyceae. cxxxix + 1315p. Padua.

De TONI G.B., 1900 - *Sylloge algarum*. Vol. IV. Florideae. Sect. II, 387-776p. Padua.

FUNK G., 1955 - *Beiträge zur Kenntnis der Meeresalgen von Neapel zugleich Mikrophotographischer Atlas*. Napoli. x + 178p., 30pls. [Reprinted 1978 by Otto Koeltz Scientific Publishers, Koenigstein, Germany.]

GARBARY D.J., HANSEN G.I. & SCAGEL R.F., 1980 - A revised classification of the Bangiophyceae (Rhodophyta). *Nova Hedwigia* 33: 145-166.

HAUCK F., 1883-1885 - Die Meeresalgen Deutschlands und Oesterreichs. *In* RABENHORST L.(Ed.), *Kryptogamen-Flora von Deutschland, Osterreich und der Schweiz*. Zweite Auflage, vol. 2, xxiv + 575p.

KORNMANN P., 1956 - Zur Morphologie und Entwicklung von *Percursaria percusa*. *Helgoländer Wiss. Meeresuntersuch.* 5: 259-272.

KÜTZING F.T., 1850-1852 - *Tabulae Phycologicae...* Vol. 2, 37p., 100pls. Nordhausen.

KÜTZING F.T., 1886 - *Tabulae Phycologicae...* Vol. 16, 35p., 100pls. Nordhausen.

MONTAGNE [J.F.]C., 1857 - Huitième centurie de plantes cellulaires nouvelles tant indigènes qu'exotiques, décades iv et v. *Ann. Sci. Nat., Bot.*, sér. 4, 7: 134-153.

PAPENFUSS G.F., 1960 - On the genera of the Ulvales and the status of the order. *J. Linn. Soc. Bot.* 56: 303-318.

PAPENFUSS G.F., 1868 - A history, catalogue, and bibliography of Red Sea benthic algae. *Israel J. Bot.* 17: 1-118.

SCAGEL R.F., GABRIELSON P.W., GARBARY D.J., GOLDEN L., HAWKES M.W., LINDSTROM S.C., OLIVEIRA J.C. & WIDDOWSON T.B., 1989 - *A synopsis of the benthic marine algae of British Columbia, Southeast Alaska, Washington and Oregon*. Phycological Contr. No. 3, Dept. of Botany, Univ. of British Columbia, Vancouver, British Columbia, Canada,. vi + 532p.

SEAGRIEF S.C., 1984 - A catalogue of South African green, brown and red marine algae. *Memoirs of the Botanical Survey of South Africa.* No. 47. 72p.

SOUTH G.R. & TITLEY I., 1986 - *A checklist and distributional index of the benthic marine algae of the North Atlantic Ocean.* Huntsman Marine Laboratory and the British Museum (Natural History), St. Andrews and London. 76p.

VINOGRADOVA K.L., 1979 - [Green seaweeds of remote seas of U.S.S.R.] V.L. Komarov Botanical Institute, Academy of Sciences of the U.S.S.R., Leningrad. 146p. [In Russian.]

WOMERSLEY H.B.S., 1984 - *The Marine Benthic Flora of Southern Australia. Part I.* Government Printer, South Australia. 329p.

WYNNE M.J., 1986 - A checklist of benthic marine algae of the tropical and subtropical western Atlantic. *Canad. J. Bot.* 64: 2239-2281.

YOSHIDA M.J., 1986 - A checklist of benthic marine algae (revised in 1990). *Jap. J. Phycol.* 38: 269-320.

ZANARDINI G., *Saggio di classificazione naturale delle Ficee.* Venice, 64 p.

ZANARDINI G., 1858 - Plantarum in mari rubro hucusque collectarum enumeratio. *Mem. Ist. Veneto Sci. Lett. Arti* 7: 209-309, pls. 3-14.

ZINOVA A.D., 1967 - [A guide to the green, brown, and red algae of the southern seas of the U.S.S.R.] V.L. Komarov Botanical Institute, Academy of Sciences of the U.S.S.R. Moscow, Leningrad. 398p. [In Russian.]

Cryptogamie, Algol. 1991, 12 (4): 289-300

CHAROPHYTA FROM BABYLON (REPUBLIC OF IRAQ)

Jelena BLAZENCIC* and Dobrina TEMNISKOVA-TOPALOVA**

*Botanical Institute and Garden, Faculty of Science,
University of Belgrade, 11000 Belgrade,
Takovska 43, Yugoslavia.
**Department of Botany, Biological Faculty,
University of Sofia "Kliment Ohridski", Bulgaria.

ABSTRACT - This paper is a contribution to investigation of charophytes of Iraq, collected from three localities on the territory of the ancient town of Babylon.

Five species are identified: *Nitella opaca* Ag., *Tolypella glomerata* (Desv. in Lois.) Leonh., *Chara vulgaris* L., *Chara gymnophylla* A. Br. and *Chara contraria* A. Br. ex Kütz. Morphological explanation, size of oogonia, antheridia and oospores as well as data on localities and geographical distribution are given for each of them according to the literature and author's observations. Ecological spectra of those species are supplemented with data on temperature and pH reaction of the water. All investigated species appear to tolerate a wider range of pH values towards more alkaline water (up to 8.5) than it is recorded in the literature, whereby *Nitella opaca* seems to have the widest range of pH tolerance. Three of them (*Nitella opaca*, *Tolypella glomerata* and *Chara contraria*) show more tolerance for high water temperature (up to 29.5°C) than it was more mentioned in literature.

RÉSUMÉ - Cette étude présente les résultats des recherches effectuées sur les Characées de la République d'Irak. Les spécimens ont été récoltés dans trois localités du territoire de l'ancienne cité de Babylone. Cinq espèces ont été déterminées: *Nitella opaca* Ag., *Tolypella glomerata* (Desv. in Lois.) Leonh., *Chara vulgaris* L., *C. gymnophylla* A. Br. and *C. contraria* A. Br. ex Kütz. La description morphologique de chaque espèce est accompagnée de la mesure des oogones, des oospores et des anthéridies, de la température et du pH de l'eau de la station, de la répartition géographique basée sur la littérature et les observations. Toutes les espèces manifestent une tolérance plus élevée du pH de l'eau par rapport à celui antérieurement publié; le spectre le plus large est observé chez *Nitella opaca*. Trois d'entre elles (*Nitella opaca*, *Tolypella glomerata* et *Chara contraria*) présentent une plus grande tolérance aux températures élevées (jusqu'à 29°5C) que celle jusqu'ici indiquée dans la littérature. (Résumé revu par la rédaction).

INTRODUCTION

First data on Iraqi algae are given by Ehrenberg (1844). A hundred years later, freshwater algae from Mesopotamia and Kurdistan have been investigated by Kolbe and Krieger (1942). Different papers on phytoplancton of lower stream of the rivers Tigris and Euphrates, Shatt al-

Arab channels and other freshwater biotops as well as on algal flora of the estuaries of Shatt al-Arab have been published since 1973 (Hirano, 1973; Saad & Kell, 1975; Kell & Saad, 1975; Huq *et al.* 1978; Kell, 1978; Saad & Samir, 1978; Al Saadi *et al.*, 1979; Pankow & Huq, 1979; Pankow *et al.*, 1979; Maulood *et al.*, 1981; Islam, 1985). Beside here mentioned studies on algae there are some others from rice fields of north-eastern Iraq (Al-Kaisi, 1976) as well as on diatoms from thermal springs of Iraqi Kardistan (Maulood & Hinton, 1979).

Searching through the literature the authors found that algae of Iraq had been studied from floristic and rarely taxonomic aspect with remarks on ecological conditions. These data relate mainly to *Bacillariophyta*, *Cyanophyta* and less to *Euglenophyta*, *Pyrrophyta*, *Rhodophyta* and *Chrysophyceae*. The majority of species that have been recorded are new not only for Iraq but even for the region of Near East.

With exception of Al Kaisi (1976) who reported *Chara formosa* Rob., *Nitella tenuissima* (Desv.) Kütz. and *Nitella* sp. from rice field (pH 6.8-8.4), charophytes of Iraq had not been studied.

Results of investigations of charophytes collected in the region of the ancient Babylon are summarized in this paper.

MATERIAL AND METHODS

Tests from three localities of charophytes (channel and two muds) in the region of the ancient Babylon have been taken in the period from May to June, 1972. City of Babylon is situated in the south of Mesopotamia, today's Iraq, in so-called lowlands of Babylon, at the altitude less than 100 m. The Tigris and the Euphrates are flowing slowly through the wide plain making numerous meanders, marshes and stable bogs and muds. These stable muds which remain during the whole year inspite of extremely high summer temperatures of 49°C even of 55°C, are probably connected with the river Euphrates.

Records of the water and air temperatures as well as pH values of the water are taken, while collected specimens are fixed in 4% formaldehide in the field.

For the purpose of identification a part of collected material was treated by 5% solution of hydrochloric acid (HCl). In process of species determination and geographical distribution the authors consulted literature data given by Migula (1897), Corillion (1957, 1975), Vodenicarov (1963), Dambska (1964), Wood & Imahori (1964, 1965), Blazencic & Cvijan (1980),Comelles (1982), Blazencic & Blazencic (1983a and b, 1986, 1989), Blazencic *et al.* (1990), Gollerbah & Krasavina (1983), Moore (1986).

Microphotographs are made by binocular lens "Zeiss" (J. Blaz.) and by microscope "Amplival" supplied by additional instrument "Mattik" for automatical recording (D. Temn.).

This collection of Charophytes sampled in Iraq by D. Temniskova is kept in Department of Botany, Biological Faculty, University of Sofia "Kliment Ohridski".

DESCRIPTION OF LOCALITIES

1. The **"Hole"**. This locality placed in the middle of the ruins of the ancient Babylon is filled up with transparent, clear and relatively cold water. Along three sides the Hole is enclosed by the 7.5m high wall, made of bricks, which protrudes 1 m above the sands. Forth side of the wall round the well is partly destroyed and from that place it is possible, with difficulty and by rope, to descend inside the Hole and reach the water surface which dimensions are about 2 x 1-1.5 meters.

Anyway this habitat might be a part of one of the channels in complex hydrosystem of the ancient Babylon. That is therefore an explanation where the clear and cold water is coming from. The bottom of the Hole is covered by authentic remains of babylonian bricks.

Almost entire free water area is covered with Charophytes associated with *Callitriche verna* L., *Mougeotia* sp., *Tribonema* sp. and the others. During July it partly dries up. Temperature of water moves between 20° and 25°C while pH values between 6.5 and 7.5 from May to October.

Dates	Hours	Temperature of water	pH
29th May	6.15 p.m.	21°C	7.5
9th June	11.00 a.m.	23°C	7.5
26th July	7.30 p.m.	25°C	7
21st August	6.45 a.m.	24°C	7.5
12th September	5.00 p.m.	22°C	7
17th October	11.30 a.m.	20°C	6.5

2. **"Little Mud"**. Site by the name of Little Mud is located beside Babylonian lion. Its surface is almost overgrown by reed (*Phragmites* sp.) up to 3.5-4 m above the water. Free water area is covered by duckweed (*Lemna* sp.).

Little Mud is 12-14 m long and about 5-6 m wide. The bottom is muddy. From May to October temperature of water fluctuates between 22°C and 29,5°C, while pH values move from 7 to 8. Records are taken from two places in *Phragmites* area:

Dates	Hours	Temperature of water	pH
9th June	10.00 a.m.	28°C	7.5-7.6
26th July	6.00 p.m.	29.5°C	8.0
21st August	6.00 p.m.	29°C	7.6
17th October	11.00 a.m.	22°C	7.0

3. **"Big Mud".** It is placed between sandy hills near by Zykkurat. Anyway, there is an island in the middle of its large free water area. The bottom is muddy and sandy. Litoral area is overgrown by reed (*Phragmites* sp.). In the period from July to the beginning of November the Big Mud partly dries up. Charophytes grow here in association with *Spirogyra* sp., *Tribonema* sp. and a lot of various diatoms and other algae. Water temperature fluctuates from 21.5°C to 29.0°C from May to October while pH values move into a range of between 7.5 and 8.5. Samples are collected from three places.

Dates	Hours	Temperature of water	pH
31st May	6.00 p.m.	29.0°C	8.0
19th June	6.00 p.m.	29.0°C	7.5
26th July	7.00 p.m.	28.0°C	8.0
21st August	7.00 p.m.	29.0°C	8.4
12th September	6.30 p.m.	26.5°C	8.3
17th October	10.00 a.m.	21.5°C	8.5

SYSTEMATIC ENUMERATION

In material collected in Babylon three genera (*Nitella*, *Tolypella* and *Chara*) with five species (*Nitella opaca* Ag., *Tolypella glomerata* (Desv. in Lois.) Leonh., *Chara vulgaris* L., *Chara gymnophylla* A. Br. and *Chara contraria* A. Br. ex Kütz) are identified. Morphological description, size of oogonia, antheridia and oospores beside the data on habitat, water temperature and pH reaction of the water as well as on geographical distribution are given for each of the species.

Nitella opaca **Agardh, 1824** (Fig. 1)

Chara opaca Bruzelins, p. 23, 1824 (= var. *flexilis*); *Nitella syncarpa* var. *opaca* (Bruz.) Kützing, p. 256, 1854 (= var. *flexilis*); *Nitella flexilis* var. *flexilis* Wood, p. 15, 1962.

Plants lightly encrusted, dark green. Branchlets 6-7 in a whorl. Only male samples are found. Antheridium 504-542 μm in diameter.

Species has been recorded only in the Big Mud growing from May to November in the water with pH between 7.5 and 8.5 and temperatures from 21.5°C to 29°C.

Geographical distribution: It is wide spread and common on the Earth between latitudes 65°N and 30°S.

Tolypella glomerata **(Desv. in Lois.) Leonhardi, 1863 (Figs 2-4)**

Chara glomerata Desvaux *in* Loiseleur-Deslongchamps, p. 135, 1810 (= var. *glomerata*); *Tolypella glomerata* (Desv. in Lois) Leonhardi, p. 129, 1863

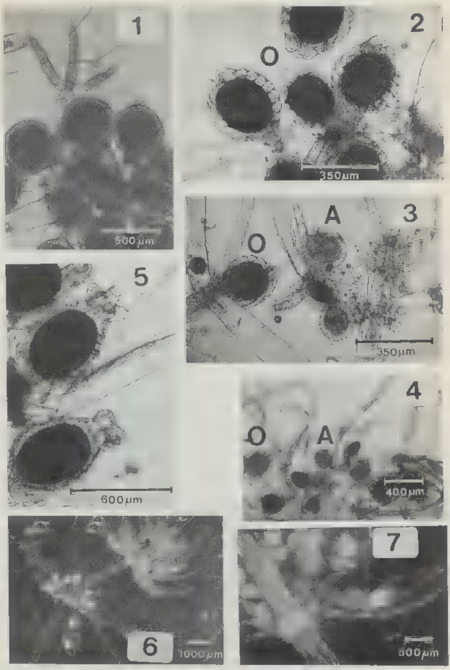


Fig. 1: *Nitella opaca* Ag., axial node with fertile branchlets. - Figs 2-4: *Tolypella glomerata* (Desv. in Lois) Leonh., branchlet node bearing mature and immature oogonia (O) and antheridium (A). - Figs 5-7: *Chara gymnophylla* A. Br. Fig. 5. Branchlet node bearing oogonia (O). Fig. 6. Terminal part of the plant. Fig. 7. Axial node with ecorticate fertile branchlets.

(= var. *glomerata*); *Tolypella nidifica* var. *glomerata* (Desv. in Lois.) Wood, p. 23, 1962.

Small plant up to 5-6 cm high, green, heavily encrusted. Structure of main axes, branches and branchlets typical. Branchlets 6 in a whorl. Gametangia conjoined at branchlets nodes. Oogonia 314-351 μm in diameter and 333.4-426.0 μm long (without coronula). Spiral-cells form 9-10 convolutions. Coronula up to 37.0 μm long and 55.6-74.1 μm in diameter. It is 30 μm longer than it is mentioned in literature. Oospores elliptic, brownish-yellow, up to 277.8 μm in diameter.

Tolypella glomerata has been recorded in both the Little Mud and the Big Mud associated with *Ch. vulgaris*, *Ch. contraria* and *Ch. gymnophylla*. It develops in the period from May to November when temperature of water moves from 21.5° to 29.5°C and pH from 7 to 8.5.

Geographical distribution: As the other algae in Babylon it is also widely distributed but not very frequent. It appears to be cosmopolitan.

***Chara vulgaris* L.** (Fig. 8)

Chara vulgaris Linnaeus, p. 1156, 1753 (= var. *vulgaris*); *Chara foetida* Braun, p. 354, 1834 (= var. *vulgaris*); *Chara vulgaris* var. *vulgaris* et f. *vulgaris* Wood, p. 73, 1965.

Plants up to 15 cm, green, lightly encrusted. Axes up to 525 μm in diameter. Internodes 2-3 times as long as branchlets. Cortex regularly diplostichous. Spine-cells solitary, globular or short-cylindrical. Stipulodes typically developed. Branchlets 8-9 in a whorl, 5-12 mm long, of 3-5 segments of which the ultimate one is ecorticate and 2-3-celled. Branchlet node with 7 bracteoles of which 4 adaxial well developed, 2.5-4 times as long as oogonia while 3 abaxial rudimentary, globose or short-cylindrical, 104-133 μm long. Gametangia at the 3-4 lowest branchlet nodes. Oogonia ellipsoid-cylindrical, 463.2-571.2 μm long (without coronula) and 285.6-370.4 μm in diameter, with 13 convolutions. Coronula 74.1-123.7 μm long and 138.2-171.3 μm wide at the base. Antheridia 314.8-333.4 μm in diameter. Oospores have not been observed.

The plant is recorded in all three habitats. Among all charophytes only *Chara vulgaris* was found to grow in the Hole where it developed in considerable density. Also, it is reported frequently as appearing in the Big Mud. Plants sampled in the Little Mud are heavily encrusted, with long branchlets and often long ecorticate terminal segment and bracteoles longer than usual, all due to low light intensity existing in habitat Little Mud where this species are growing among reed.

It develops from May to November at the water temperatures of between 20° and 29°C and pH of 6.5-8.5.

Geographical distribution: Being cosmopolitan it appears throughout the world between the latitudes 70°N and 50°S.

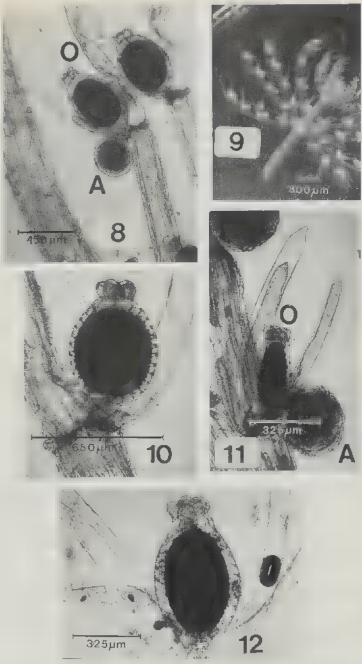


Fig. 8: *Chara vulgaris* L., branchlet node with oogonia and antheridium. - Figs 9-12: *Chara contraria* A. Br. ex Kütz. Fig. 9. Terminal part of the plant. Fig. 10 and 12. Branchlet nodes bearing mature oogonia. Fig. 11. Immature oogonium (O).

Chara gymnophylla **A. Br.** (Figs 5-7)

Chara foetida var. *gymnophylla* Braun, p. 354, 1834; *Chara vulgaris* f. *gymnophylla* (A.Br.) Hy, p. 240, 1914; *Chara vulgaris* var. *gymnophylla* f. *gymnophylla* Wood, p. 8, 1962.

Plants up to 12 cm high, lightly encrusted, green. Main axes and branches flexible, about 0.5 mm wide. The longest internodes 2-4 times as long as branchlets. Cortex structure, spine-cells and spinulodes typically developed. Branchlets 9 up to 2 cm long, delicate, ecorticate or 1-2 of the lowest segments may be corticate. Bracteoles 7 of which adaxials even 9-10 times as long as oogonium. Gametangia conjoined at the first lowest branchlet node. Oogonia ellipsoid, 481.5-555.6 μm long (without coronula) and 14.4-361.6 μm in diameter with 12-13 convolutions. Coronula 92.6-111.1 μm long and 129.6-161.8 μm wide at the base. Oospores have not been recorded. Antheridia 295-351.9 μm in diameter.

This species have been found in both localities the Little Mud and the Big Mud although less present than the others. It develops at the water temperatures ranged from 21.5° to 29.5°C and pH levels of between 7 and 8.5 from May to November.

Geographical distribution: It is recorded in Europe, Africa and Asia.

Chara contraria **A. Br. ex Kütz. (Figs 9-12)**

Chara contraria subsp. *contraria* (A. Br. ex Kütz.) Braun. p. 788, 1867 (= f. *contraria*): *Chara foetida* var. *contraria* (A. Br. ex Kütz.) Cosson et Germain, pl. 41, 1882 (= var. *vulgaris*); *Chara vulgaris* var. *vulgaris* f. *contraria* (A. Br. ex Kütz.) Wood, p. 73, 1965.

Plants up to 19.5 cm high and 371-761 μm in diameter, bright green and moderately encrusted. The longest internodes 2-2.5 times as long as branchlets. Cortex, spine-cells and stipulodes, both tiers, typically developed. Branchlets 7-9, 1.2-1.7 cm long, of 3-5 segments corticate and terminal one up to 0.36 cm long, ecorticate and 3-celled. Bracteoles 7 of which 4 adaxial 3-5 times as long as oogonia. Gametangia mostly at the 3 lowest branchlet nodes. Oogonia 523.6-648.2 μm long (without coronula) and 370.4-447.5 μm in diameter. Convolutions 12-13. Coronula 74-92.6 μm long and 142.8-185.2 μm in diameter at the base. Oospores ellipsoid, up to 518.6 μm long and 314.8-333.4 μm wide. Antheridia vary from 351.9 to 447.5 μm in diameter.

Chara contraria is found in both the Little Mud and the Big Mud. Samples collected from Little Mud seem to be more encrusted than those from Big Mud where species develops in considerable density. It grows between between May and November at water temperatuers ranged from 21° to 29°C and pH between 7.5 and 8.5.

Geographical distribution: Widespread species as *Chara vulgaris*.

DISCUSSION

Morphological characteristics. Comparative analysis of literature data and authors' observations points out certain but insignificant differences that are in a range of expected individual variations (Migula, 1897; Dambska, 1964; Wood & Imahori, 1964, 1965; Corillion, 1975; Gollerbach & Krasavina, 1983).

In connection with status of species *Chara gymnophylla* it has been long debated through the literature in attempt to define it more precisely, remaining actual even nowadays. Morphological observations of differential taxonomic characters in species *Chara gymnophylla* and *Chara vulgaris* sampled in Babylon show the greatest degree of morphological variation such as different degree of branchlets cortication: there are examples with quite ecorticate branchlets bearing gametangia, up to those which 1 or 2 segments are corticated. All these combinations can be found on the same individual, even on the branchlets of the same whorl.

However, this appearance points out the evidence, the most acceptable among the modern authors, that *Chara gymnophylla* might be regarded as subspecies within species complex of *Chara vulgaris* (Corillion, 1975) which different morphological characteristics appear mostly to be induced by ecological conditions such as water temperature, pH reaction of the water, etc.

Geographical distribution. All species identified in Babylon appear to be cosmopolitan in distribution. They are recorded almost all over the continents including Asia but, as the authors could find concerning the literature, are not mentioned in Iraqi flora.

Ecological observations. Locality called the Hole is a sort of well which differs from the other two investigated localities by its physical characteristics as well as by the presence of *Chara vulgaris*, the only of charophytes that grows here. Other two localities are the bogs where the mentioned species are growing with exception of *Nitella opaca* which grows only in the Big Mud close to the river Euphrates. The fact that *Nitella opaca* tends to develop only in the stable streaming water suggests that the Big Mud is connected with the Euphrates by the channels of the ancient hydrosystem or could be supplied by the underground water.

As it appears to tolerate low light intensity (Migula, 1897) *Nitella opaca* grows in the shaded places of the Big Mud, in the zone of reed (*Phragmites* sp.), at the depths of 0.5-0.7 m, making the lowest plant layer together with *Chara contraria* which higher thallus reaches the water surface.

Comparing literature data on water temperature and pH values with their own observations in Babylon, the authors have made following conclusion. Five species of charophytes investigated in Babylon develop at the water temperature of between 20° and 29°C. During the months of June, July and August water temperatures were found to vary about 28-29.5°C. Otherwise, high water temperatures which reach 30°C were noticed in literature only for *Chara vulgaris* and *Chara gymnophylla* (Corillion, 1957).

Consulting literature the authors found *Chara vulgaris* to tolerate pH range of 7-8.5 (Corillion, 1957, 1975). Meanwhile, searching the locality "Hole" in Babylon, the authors discovered this species to grow in considerable density in the water with pH ranged from 6.5 to 8.5 showing thus more tolerance towards pH reaction of the water than it is reported in literature. It is also recorded pH values 7-8 for *Chara contraria*, 7.3-7.8 for *Chara gymnophylla* as well as 7-7.8 for *Tolypella glomerata* (Corillion, 1957, 1975) while the authors found these species in Babylon to grow in water with pH from 7 to 8.5 showing thus to be able to tolerate higher pH values than it is recorded in literature. As it is known from literature *Nitella opaca* tolerates pH values ranged between 6.3 and 7.5 (Corillion, 1957, 1975). Stroede (1931) found it to grow under the conditions of pH values of about 6 (5.16-6.3 precisely) while Höll (1928) mentioned pH 7.63 as the highest level for this species (quoted from Stroede, 1931). Blazencic & Blazencic (1983, 1986, 1989) registered several localities in Yugoslavia with pH 7-8. It means that *Nitella opaca* can tolerate wider range of pH values than it was considered before.

On the whole, according to the new evidence reported from Babylon, it can be concluded that *Chara contraria*, *Nitella opaca* and *Tolypella glomerata* appear to tolerate higher water temperatures than it was known. Besides, all mentioned species seem to be more tolerant towards more alkaline water (7-8.5) whereas the range of pH tolerance in *Nitella opaca* appears to be the widest.

ACKNOWLEDGEMENTS

Some literature data on Iraqi algae have been obtained by the kindness of professor Dr. K. Anagnostidis from Botanical Institute of University of Athens what we are the most grateful for. The authors are especially indebted to Mrs. Vesna Sakic who has translated this work in English.

REFERENCES

AL-KAISI K.A., 1976 - Contributions to the algal flora of the ricefields of southeastern Iraq. *Nova Hedwigia* 27: 813-827.

AL-SAADI H.A., PANKOW H. & HUQ M.F., 1979 - Algological Investigations in the Polluted Ashar Canal and Shatt al-Arab in Basrah (Iraq). *Int. Revue ges. Hydrobiol.* 64: 527-540.

BLAZENCIC J., 1980 - Contribution to the study of distribution and ecology of species of the genus *Chara* in Serbia. *Glasnik Prirodnjackog muzeja*, ser. B 35: 103-105.

BLAZENCIC J. & CVIJAN M., 1980 - *Nitellopsis* Hy. (*Tolypellopsis* Mig.) - the new genus for the flora of Yugoslavia from the division of Charophyta. *Glas. Republ. zavoda zast. prirode - Prirodnjackog muzeja Titograd* 13: 7-13.

BLAZENCIC J. & BLAZENCIC Z., 1983a - *Lychnothamnus* (Rupr.) (Characeae) a new genus to the flora of Yugoslavia. *Acta Bot. Croat.* 42: 95-101.

BLAZENCIC J. & BLAZENCIC Z., 1983b - Contribution to the knowledge of Charophyta of lake Skadar. *Radovi sa Simpozijuma Skadarsko jezero, CANU, Naucni skupovi, knj.* 9: 259-264.

BLAZENCIC J. & BLAZENCIC Z., 1986 - Flora and vegetation of algae belonging to the division Charophyta in mountain lakes of Montenegro. *Glasnik Odjeljenja prirodnih nauka CANA* 5: 189-203.

BLAZENCIC J. & BLAZENCIC Z., 1989 - The floristic-chorological analysis of algae belonging to the division Charophyta in Bosnia and Hercegovina. Zemaljski muzej BiH. Zbornik radova naucnog skupa "Minerali, stijene, izumrli i zivi svijet BiH", pp. 223-233.

BLAZENCIC J., URBANIC-BERCIC O. & VRHOVSEK D., 1990 - Macrophytes in the lakes of the Triglav national park. *Biol. vestn.* 38: 1-14.

BRAUN A., 1834 - Esquisse monographique du genre *Chara*. *Ann Sci. Nat. Bot.*, sér. 2, vol. 1: 349-357.

BRAUN A., 1867 - Die Characeen Afrika's. *Monatsber. K. Akad. Wiss.*: 782-801, 873-944.

BRUZELINS A., 1824 - *Observaciones in genus Charae*. Dissert., Lund, 24 p.

COMELLES M., 1982 - *Noves localitats i revisio de la distribucio de les especies de carofits a Espanya*. Tesis Licenciatura, Univ. Barcelona, p. 147.

CORILLION R., 1957 - Les Charophycées de France et d'Europe occidentale. *Bull. Soc. Sci. Bretagne* 32, fasc. hors série.

CORILLION R., 1975 - *Flore et végétation du massif Armoricain. IV Flore des Charophytes (Characées) du massif Armoricain et des contrées voisines d'Europe occidentale.* Paris.

COSSON E. & GERMAIN de SAINT-PIERRE E., 1982 - *Atlas de la flore des environs de Paris.* 2ème éd., Paris.

DAMBSKA I., 1964 - Charophyta-Ramienice. Flora Sladkowodna Polski, Tom 13.

DESVAUX A.N., 1810 - Characeae. *In* LOISELEUR-DESLONGCHAMPS J.L.A., *Notice sur les plantes à ajouter à la flore de France.* Paris, pp. 135-139.

EHRENBERG C.C., 1844 - Untersuchungen über die Kleisten Lebensformen im Quellenlande des Euphrates und Araxes, so wie über eine an neuen Formen sehr reiche marine Tripelbildung von dem Bermuda-Inseln. Bericht über Bekanntmachung geegn. Verh. der königl. preuss. Akad. der Wissensch. Berlin, pp. 253-275.

GOLLERBAH M.M. & KRASAVINA L.K., 1983 - Opredelitel presnovodnih vodoroslej SSSR, 14. Harovie vodorosli-Charophyta. Leningrad.

HIRANO M., 1973 - Freshwater Algae from Mesopotamia. *Contr. Biol. Lab. Kyoto Univ.* 24: 105-119.

HUQ M.F., AL-SAADI H.A. & HAMMED H.A., 1978 - Phytoplankton ecology of Shatt al-Arab river at Basrah, Iraq. *Verh. Internat. Ver. Limnol.* 20 (3): 1552-1556.

HY F., 1914 - Les Characées de France. Note additionnelle. *Soc. Bot. France* 61: 235-241.

ISLAM A.K.M., 1985 - Some new rare freshwater algae from Iraq. *Int. Revue Ges. Hydrobiol.* 70: 755-766.

KELL V., 1978 - Weite Notizen zum Phytoplankton des Shatt al-Arab (Iraq). *Wiss. Zeischr. Wilhelm-Pieck-Univ., Rostock, Math. nat. R.* 27: 19-26.

KELL V. & SAAD M.A.H., 1975 - Untersuchungen über das Phytoplankton und einige Umweltparameter des Shatt al-Arab (Iraq). *Int. Rev. Ges. Hydrobiol.* 60: 409-421.

KOLBE R.W. & KRIEGER W., 1942 - Süsswasseralgen aus Mesopotamien und Kurdistan. I. Diatomeen. *Ber. Deutsch. Bot. Ges.* 60 (6-7): 336-355.

KÜTZING F.T., 1845 - *Phycologia germanica*. Nordhausen, x + 240 p.

LEONHARDI H. von, 1863 - Die böhmischen Characeen. *Lotos* 13: 55-80, 110-111.

LINNAEUS C. von, 1753 - *Species plantarum* II. Holmiae.

MAULOOD B.M. & HINTON G.C., 1979 - Tychoplanctonic Diatoms in stenothermal spring in Iraqi Kurdistan. *Brit. Phycol. J.* 14: 175-183.

MAULOOD B.M., HINTON G.C.F., WHITTON B.A. & AL-SAADI H.A., 1981 - On the algal ecology of the lowland Iraqi marshes. *Hydrobiologia* 80 (3): 269-276.

MIGULA W., 1897 - *Die Characeen Deutschlands, Oesterreichs un der Schweiz.* Leipzig.

MOORE J.A., 1986 - *Charophytes of Great Britain and Ireland.* BSBI Handbook N° 5, London.

PANKOW H. & HUQ M.F., 1979 - Diatoms in the stomach content of *Pseuapocryptes dentatus*, a mudskipper from the Shatt al-Arab estuary (Iraq). *Wiss. Zeitdchr. Wilhelm-Pieck-Univ., Rostock, Math. Nat. R.* 28: 547-554.

PANKOW H., AL-SAADI H.A., HUQ M.F. & HADI R.A.M., 1979 - On the algal flora of the marshes near Qurna (Southern Iraq). *Willdenowia* 8: 493-506.

SAAD M.A.H. & KELL V., 1975 - Observations on some environmental conditions as well as phytoplancton blooms in the lower reaches of Tigris and Euphrates. *Wiss Zeitschr. Wilhelm-Pieck-Univ., Rostock, Math. Nat. R.* 24: 781-787.

SAAD M.A.H. & SAMIR A.E., 1978 - Limnological studies on the river Tigris, Iraq. III. *Int. Rev. Ges. Hydrobiol.* 63 (6): 801-814.

STROEDE W., 1931 - *Ökologie der Characeen.* Dissert. Berlin, 119 p.

VODENICAROV D., 1963 - Prinosi km geografitaja na vodoraslite. I. Razprostranennie na harofite vodorasli (Charophyceae) v Blgarija. Tr. na vissie pedagogiceski Institut, Plovdiv, Biol. 1, B. 1 pp. 89-94. Plovdiv.

WOOD R.D., 1962 - New combinations and taxa in the revision of Characeae. *Taxon* 11 (1): 7-25.

WOOD R.D. & IMAHORI K., 1964 - *A revision of the Characeae. Second part. Iconograph of the Characeae.* Weinheim, 395 pl.

WOOD R.D. & IMAHORI K., 1965 - *A revision of the Characeae. First part. Monograph of the Characeae.* Weinheim, 904 p.

OUVRAGES REÇUS POUR ANALYSE

LEE R.E., 1989 - **Phycology.** Second edition. Cambridge University Press. xv + 645 p. Prix £ 37.50, $ 59.50 (hardback); £ 17.50, $ 29.95 (paperback)

La systématique des algues constitue, après une introduction très claire (49 p.), l'essentiel de ce livre. Les algues sont réparties dans quatre groupes fondés sur le nombre de membranes qui enveloppent le chloroplaste: 1) les algues procaryotes, sans membrane (Cyanophyta et Prochlorophyta); 2) les algues avec des procaryotes photosynthétiques endosymbiotiques (Glaucophyta), et dont les chloroplastes sont enveloppés par les deux membranes chloroplastiques classiques (Rhodophyta et Chlorophyta); les algues dont l'enveloppe du chloroplaste est entourée par 3) une membrane du reticulum endoplasmique chloroplastique (Euglenophyta et Dinophyta), ou par 4) deux membranes du reticulum endoplasmique chloroplastique (Cryptophyta, Chrysophyta, Prymnesiophyta, Bacillariophyta, Raphidophyta, Xanthophyta, Eustigmatophyta et Phaeophyta). Un glossaire et un index terminent le volume. Signalons la présence de courtes biographies d'algologues accompagnées de photographies.

Cette nouvelle édition, complètement revue et très bien illustrée, est un ouvrage parfait pour les enseignants et étudiants.

P. Bourrelly

YAMAGISHI T. et AKIYAMA M. (Eds.), 1988-1989 - **Photomicrographs of the Freshwater algae.** Uchida Rokakuho, Tokyo.

Comme les tomes précédents, chaque volume renferme 100 planches de microphotos d'algues d'eau douce de tous les groupes (Diatomées exclues). Pour chaque fiche nous avons une excellente microphoto, un dessin, la bibliographie du taxon et la description en anglais; dans le volume 10 nous trouvons l'index alphabétique des 10 volumes (1000 taxons) parus, index qui permet une utilisation aisée de cette iconographie. La présentation en fiche à marge perforée permet à chacun de classer les fiches à son gré.

Nous avons là une très bonne documentation qui fait la synthèse des ouvrages classiques de systématique des algues d'eau douce.

P. Bourrelly

PANKOW H., 1990 - **Ostee-algenflora.** Gustav Fischer Verlag, Jena. 1 vol., 648 p.

Ce volume étudie la systématique et l'écologie des algues d'eau douce et saumâtre de la Baltique. Tous les groupes algaux sont traités, des Cyanophycées aux Rhodophycées, y compris les Diatomées. Des clefs dichotomiques permettent d'arriver au genre et à l'espèce. L'illustration est abondante et très soignée; avec 1738 figures dans le texte, et 6 planches de microphotos de Diatomées, une bibliographie très complète termine ce volume. Il s'agit d'un ouvrage dirigé par Pankow assisté de l'équipe du laboratoire de Rostock avec V. Kell, N. Wasmund et B. Zander.

Ce volume est indispensable à tous les algologues étudiants les eaux saumâtres.

P. Bourrelly

KOMAREK J. et WATANABE M., 1990 - **Morphology and taxonomy of the genus *Coleodesmium* (Cyanophyceae/Cyanobacteria).** *In* Watanabe M. et Malla S.B. (Eds.), *Cryptogams of the Himalayas, 2: Central and Eastern Nepal.* Dept. Bot. Nat. Sci. Museum Tsukuba Japan, pp. 1-22.

Les auteur précisent la définition du genre qui renferme 7 espèces (et 10 taxons). Ils décrivent une espèce nouvelle du Japon et du Népal et présentent 3 comb. nov. Tableau des 10 taxons et excellentes figures.

NOZAKI H., 1990 - **Colonial Volvocales (Chlorophyta) from Central and East Nepal.** *Loc. cit.*, pp. 41-47.

L'auteur signale 3 espèces peu connues des genres *Volvulina, Astrephomene* et *Pyrobotrys.* Il précise leurs caractères taxinomiques et leur reproduction.

P. Bourrelly

NECCHI O. Jr., 1990 - **Revision of the genus *Batrachospermum* Roth (Rhodophyta, Batrachospermales) in Brazil.** Bibliotheca Phycologica 84: 1-201.

L'auteur signale 27 espèces de *Batrachospermum* au Brésil et décrit 2 espèces nouvelles: *B. densiverticillatum* et *B. longiarticulatum.* Pour chaque espèce il indique la répartition mondiale et la distribution au Brésil. L'illustration est abondante (dessins et photographies): 270 figures. Clefs de détermination, tableaux des caractères systématiques complètent cette intéressante étude et en font un opuscule qui rendra service à tous les algologues.

P. Bourrelly

SIEMINSKA J., 1990 - **Polska bibliografia fykologiczna** (The Polish Phycological Bibliography) Polska Akad. Nauk, Onst. Bot. Wl. Szafera, Krakow, Bibl. Bot. 3: 464 p.

Ce volume indique toutes les références bibliographiques des travaux consacrés à l'algologie en Pologne. Il signale 3050 travaux classés par ordre alphabétique depuis une note de Stanko J. en 1972 sur un *Nostoc,* à l'époque actuelle (1990). Les recherches sont facilitées par une série d'index terminant le volume: index par groupes systématiques (Bacillariophyceae, Chlorophyta, etc.), puis par régions, par biotopes, enfin par régions non polonaises.

Comme on le voit par cette brève analyse cet ouvrage rendra service à tous les algologues.

P. Bourrelly

TABLE DU TOME 12

Commission paritaire 16-1-1986 - N° 60590 - Dépôt légal n° 15840
Imprimerie de Montligeon - Sortie des presses le 20 novembre 1991 - Imprimé en France
Éditeur : A.D.A.C. (Association des Amis des Cryptogames)
Président : R. Baudoin; Secrétaire : D. Lamy
Trésorier : J. Dupont; Directeur de la publication : H. Causse